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REPORT OF PROCEEDINGS

OF THE

ELEVENTH ANNUAL MEETING

OF THE

American Water Works Association,

HELD AT

PHILADELPHIA, PA.,

144212.
1/11/17.

APRIL 14, 15, AND 16, 1891.

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Officers for 1891-2.

President,

J. M. DIVEN, - - - - - - Elmira, N. Y.

Vice-Presidents.

G. H. BENZENBERG, - - - Milwaukee, Wis.
JOHN L. OGDEN, - - - - - Philadelphia, Pa.
JOSEPH A. BOND, - - - - - Wilmington, Del.
H. G. HOLDEN, - - - - - - Nashua, N. H.
W. G. RICHARDS, - - - - - Atlanta, Ga.

Acting Past-President.

WM. B. BULL, - - - - - - - Quincy, Ill.

Finance Committee.

JAMES P. DONAHUE, - - - - - Davenport, Ia.
WM. MOLIS, - - - - - - - Muscatine, Ia.
WM. RYLE, - - - - - - - Paterson, N. J.

Secretary and Treasurer.

J. H. DECKER, - - - - - New York, N. Y.

Standing and Special Committees.

General Arrangements.

H. W. AYRES, Chairman, - - - Hartford, Conn.
J. T. SAWYER, - - - - - Waverly, N. Y.
L. J. WAGNER, - - - - - - - Rome, Ga.
CHARLES HOOD, - - - - - Burlington, Ia.
GEO. E. BOOKER, - - - - San Francisco, Cal.

Local Arrangements.

PETER MILNE, Jr., Chairman, - - New York, N. Y.
JNO. C. KELLEY, - - - - " " "
JARVIS B. EDSON, - - - - " " "
RUDOLPH HERING, C. E., - - - " " "
H. R. WORTHINGTON, - - - " " "
J. L. MOTT IRON WORKS, - - - " " "

Vegetable and Animal Growths Affecting Water Supplies.

FROF. ALBERT R. LEEDS, Chairman, Hoboken, N. J.
L. J. LECONTE, - - - - - - Oakland, Cal.
L. H. GARDNER, - - - - New Orleans, La.

ELEVENTH ANNUAL CONVENTION

OF THE

AMERICAN WATER WORKS

ASSOCIATION,

HELD AT

PHILADELPHIA, MAY 14-17, 1891.

FIRST DAY.

MORNING SESSION, Tuesday, April 14, 10 A. M.

The president called the meeting to order, and stated that hereafter the meetings would be called promptly to order at the time advertised to occur.

The Secretary then called the roll and the following members responded or were reported present:

ACTIVE.

Abbott, E. L.....New York, N. Y.
Alexander, W. A.....Wilkinsburg, Pa.
Alsterlund, J. F.....Moline, Ill.
Artingstall, Samuel G.....Chicago, Ill.
Ayers, H. W.....Hartford, Conn.
Ayers, Sylvanus, Jr.....Bound Brook, N. J.
Babcock, S. E.....Little Falls, N. Y.
Ball, Phinehas.....Worcester, Mass.
Benzenberg, G. H.....Milwaukee, Wis.
Birkinbine, Harry.....Philadelphia, Pa.
Bond, Jos. A.....Wilmington, Del.
Brooks, Isaac W.....Torrington, Conn.
Brown, Calvin S.....Boston, Mass.
Brown, Milton A.....Perth Amboy, N. J.
Brush, Chas. B.....Hoboken, N. J.
Bull, Wm. B.....Quincy, Ill.

Burnett, Muscoe.....Paducah, Ky.
Booker, Geo. E.....San Francisco, Cal.
Cassin, Isaac S. Jr.....Philadelphia, Pa.
Cattell, Alex. G.....Merchantville, N. J.
Caulfield, John.....St. Paul, Minn.
Chase, John C.....Wilmington, N. C.
Coggeshall, R. C. P.....New Bedford, Mass.
Cole, Jno. A.....Hyde Park, Ill.
Decker, J. H.....Salina, Kan.
Denman, A. N.....Des Moines, Ia.
Diven, J. M.....Elmira, N. Y.
Donahue, J. P.....Davenport, Ia.
Doran, Hugh F.....Port Huron, Mich.
Dunbar, E. L.....Bay City, Mich.
Dalzell, R. H.....Chicago, Ill.
Elmer, Howard.....Waverly, N. Y.
Farnum, Peter E.....Port Jervis, N. Y.
Fish, J. B.....Scranton, Pa.
Fritchman, W. H.....Peoria, Ill.
Gardner, L. H.....New Orleans, La.
Geyelin, E.....Philadelphia, Pa.
Glore, W. H.....Covington, Ky.
Gow, R. M.....Medford, Mass.
Guilford, A. J.....Chicago, Ill.
Glover, Albert S.....Boston, Mass.
Hague, C. A.....New York, N. Y.
Harlow, Geo. R.....Pittsburgh, Pa.
Harrison, H. H.....Stillwater, Minn.
Haynes, Jos. E.....Newark, N. J.
Holden, H. G.....Nashua, N. H.
Holly, Frank W.....Lockport, N. Y.
Hood, Charles.....Burlington, Ia.
Jones, C. A.....Kansas City, Mo.
Keeler, H. E.....Chicago, Ill.
Knickerbocker, Jno.....Troy, N. Y.
Kuehn, Jacob L.....York, Pa.
Leeds, Albert R.....Hoboken, N. J.
McCallum, A.....Philadelphia, Pa.
McElroy, Samuel.....Brooklyn, N. Y.
Martin, Robert K.....Baltimore, Md.
Mather, Edmund.....Harrisburg, Pa.
Milne, Peter, Jr.....Brooklyn, N. Y.
Molis, Wm.....Muscatine, Ia.
Ogden, Jno. L.....Philadelphia, Pa.
Owen, James.....Montclair, N. J.
Page, J. B.....Lynchburg, Va.
Phipps, E. H.....West Haven, Conn.
Prentice, Allen T.....Chicago, Ill.
Priddy, C. N.....Leadville, Colo.
Richards, W. G.....Atlanta, Ga.
Rider, Jos. B.....So. Norwalk, Conn.
Ryle, Wm.....Paterson, N. J.
Sawyer, J. T.....Waverly, N. Y.

Shepperd, F. W.....New York, N. Y.
Smith, Anthony P.....Newark, N. J.
Straw, Lafe W.....Danville, Ill.
Shannahan, W. E.....Easton, Md.
Tilden, Jas. A.....Boston, Mass.
Thompson, Josiah.....Philadelphia, Pa.
Wilkerson, J. H.....Bowling Green, Ky.
Wing, Geo. B.....Kansas City, Mo.
Woodruff, Timothy.....Bridgeton, N. J.
White, Jos. E.....Easton, Md.
Wagner, L. J.....Rome, Ga.
Yardley, Thos. W.....Chicago, Ill.

ASSOCIATE.

Bourbon Brass and Copper Wks.....Cincinnati, Ohio.
Canton Water Wks.....Canton, Ohio.
Chattanooga Foundry and Pipe Wks.....Chattanooga, Tenn.
Wm. L. Clark.....Newark, N. J.
Deane Steam Pump Co.....Holyoke, Mass.
Devenshire, Easton.....Chicago, Ill.
Eddy Valve Mfg. Co.....Waterford, N. Y.
Edson, Jarvis B.....New York, N. Y.
Fisher Governor Co.....Marshalltown, Ia.
Galvin Brass and Iron Wks.....Detroit, Mich.
Gordon Steam Pump Co.....Hamilton, Ohio.
Hersey Mfg. Co.....Boston, Mass.
Holly Mfg. Co.....Lockport, N. Y.
Illinois Malleable Iron Co.....Chicago, Ill.
Kellogg, E. H. & Co.....New York, N. Y.
Ludlow Valve Mfg. Co.....Troy, N. Y.
Marsh, W. H.....New York, N. Y.
National Meter Co.....New York, N. Y.
National Tube Wks. Co.....McKeesport, Pa.
Paul, A. G.....New York, N. Y.
Rouse & Hills Co.....Cleveland, O.
Rensselaer Mfg. Co.....Troy, N. Y.
Smith, N. P.....Norfolk, Va.
Standard Thermometer Co.....Peabody, Mass.
Thompson Meter Co.....New York, N. Y.
Union Water Meter Co.....Worcester, Mass.
Wood, R. D. & Co.....Philadelphia, Pa.
Worthington, H. R.....New York, N. Y.
Wortley, Ted & Co.....Kansas City, Mo.

The President: I am surprised, as well as pleased, that so many members are present from so many different parts of the country. The next regular business is the reading of the minutes of last meeting, and inasmuch as the minutes of last meeting comprise some hundreds of pages I have no doubt you will be willing to dispense with them.

It was moved and seconded that the reading of the minutes of last meeting be dispensed with.

Adopted.

The following applications for active membership were read by the Secretary.

B. F. Steben, Sec'y. and Treas. Water Wks. Dept.....Brockville, Ont.
Jas. E. Harlow, Constructing Engineer.....Pittsburgh, Pa.
R. M. Clayton, City Engineer.....Atlanta, Ga.

It was moved and seconded that the rules be suspended and that the Secretary cast the vote of the Asso-tion for the foregoing applicants.

Carried.

PRESIDENT'S ADDRESS.

Members of the American Water Works Association:

GENTLEMEN—Accept my fraternal greeting and congratulations upon the auspicious opening of this our Eleventh Annual Convention.

I congratulate you upon the growth and prosperity of our Association, upon our choice of this beautiful and historic city as the place of holding this convention, upon the fact that death has made no inroads upon our membership since last we met, and that so many are here. Most of the old familiar faces, and several new ones.

Those familiar faces! How pleasant is the sight of them again—and the meetings, and the greetings, which this yearly reunion makes possible.

Where else can we expect to find an environment so harmonious, associates so sympathetic; dissimilar as we may appear, some old, some young, some grave, others jovial, a common bond of fellowship unites us, and there is great satisfaction in the knowledge that in spite of apparent differences, we are in fact, all birds of a feather. We need these occasonal reunions, more, in fact, than men engaged in other business or professions, for ours is a lonesome calling; from the nature of it there can be but few of us in a place, and it behooves us, when opportunity permits, to assemble ourselves together, even at much fatigue of travel, and expenditure of time and money.

I thank the pioneers of our Association, whose enterprise eleven years ago, made possible these occasions of profit and enjoyment. The growth of our Association from that nucleus of twenty-nine and its present membership of nearly three hundred and fifty is most encouraging.

The Association has grown to its full stature. Numerically, we are as strong as we ever need to be, but in one essential respect we are weak.

To refer to our reluctance as individuals to contribute of our experience or study in the shape of papers for the consideration of these conventions. One of our ablest members wrote me recently that he should attend this convention without a paper, but in an entirely receptive state

of mind; too much mental receptivity in such an organization as ours, is as fatal as the dry-rot. I must not be understood as criticising the conclusions reached by the gentleman referred to, for the value of his past services to the Association entitles him to a respite from his labors whenever he wishes to take it, but is it not apparent that a greater sense of individual responsibility will decidedly promote the ends for which we are organized: we should be willing to give, as well as take, to feed others as well as to be fed ourselves.

With this reminder I hope the appeal we shall shortly receive from the Secretary for our contributions to the covention of 1892 will not be dismissed, except for cause. Our papers need not be long to be good, they need not be formal or profound, a good proportion may even be local or special in their character, going into the minutiae of particular local happenings or conditions without loss of interest. Indeed, it appears to me that in the effort to prepare papers which shall have some bearing upon, and relation to every other water works plant here represented there is danger that after awhile some topics may lose their interest. Also that the patience of those members who never shirk their duties in the matter of the preparation of papers may become exhausted.

The year that has passed since we separated at Chicago has neither introduced or promised any radical changes in our venerable vocation. I say "venerable," for men have been hewers of wood, and drawers of water, for their fellows, since the infancy of the human race, and after ages of practice and improvement changes come slowly. One of the earliest water works men of whom we have any record, was Jacob, who drew the water for Laban's flocks, and from his presumably primitive methods, which must have strained his young back, to the Compound Condensing Pumping Engine of to-day, is such a great stride forward that the end of improvements seems nearly reached; henceforth, in the amplifying of supplies of water, in cheapening the cost of furnishing it, in delivering it to the consumer, pure, attractive and innocuous, lie perhaps the chief hopes of him who looks for further improvement. A great deal of attention and thought is being bestowed upon this last named matter, the purification of water; perhaps as conspicuous advances have been made in this department as in any other during the year, but there is, as we know, much that is still obscure in certain forms of impurity, and the deterioration of water supplies through the growth of animal and vegetable organisms. The theme is a hackneyed one; no water works convention is complete without a reference to this well-discussed subject. I am informed that the Am. Soc. C. E. is so impressed with the need of further knowledge upon this partially-comprehended subject, that they have expressed a desire to cooperate with this Association in a further search for causes and remedies. I hope this matter will receive the careful attention of the convention at the proper time.

Our past President, in his address at Chicago last year, alluded to the growth in many parts of the United States, of a feeling hostile to corporate ownership of water works property. I regret that this feeling, or prejudice seems to be increasing, rather than subsiding. I should be glad to believe that the sentiment referred to is sectional, and not general, but am forced to the conclusion that there is a general concen-

sus of public opinion which favors extreme municipal control and regulation of the water works business, and other undertakings of a semi-public character, when they are under corporate or private ownership. Since much the values of our properties, when they are thus owned, depends upon the rights and protection afforded by our franchises, the construction of these latter, if by expiration or otherwise they come to be reconstructed, needs to be scrutinized with great care. I am glad to see that our programme contains a paper bearing upon this question, and believe there are few subjects that will better repay our attention or discussion.

I will not delay the business of the convention by a long address, but will finish my greeting with the suggestion that in our plans for the disposition of our time here, we have in mind that we are assembled here primarily for business, and that we get our business done, before proceeding to enjoy ourselves. Also that our proceedings should be so easy and fraternal that the most diffident member need not hesitate to express his opinion upon whatever is under discussion; oftentimes the experience of those least accustomed and desirous of expressing their views in public is of most value.

MR. DECKER: I notice in his opening address the president stated that there had been no loss of a member by death. I desire to call your attention as well as the attention of the convention to the death of our fellow member, Dr. George Baird, who died by the hands of an assasin in Wheeling, Va.

THE PRESIDENT: Is it the wish of the convention that any action be taken on the death of Mr. Baird?

On motion, the secretary was directed to make proper notice of Mr. Baird's death in the annual report.

THE PRESIDENT: The next order of business would ordinarily be the report of the Executive Committee. We have not yet been able to get a meeting of the Committee; therefore we will proceed to the next order of business, which is the report of the Secretary and Treasurer.

REPORT OF SECRETARY AND TREASURER.

To the Officers and Members of the American Water Works Association:

GENTLEMEN: I have the honor to submit herewith the Eleventh Annual Report of the Secretary and Treasurer of the Association.

Since the last report we have lost one member by death, Dr. George Baird, of Wheeling, W. Va.

During the year we have added to our membership sixty-two new members; eleven have been dropped from the roll, for non-payment of dues; three have resigned, Messrs. A. F. Kent, W. H. Searles and S. W.

Harris; and, as noted above, death has claimed one, leaving a net gain of forty-seven members. There are now enrolled 1 Honorary, 286 Active and 74 Associate members, a total of 359.

CASH STATEMENT.

Balance on hand last report			$129 91
Rec'd from Admission Fees	$435		
" " Annual dues	980		
" " Sales of Proceedings	19 25	1,434 25	
		1,564 16	

DISBURSEMENTS.

Sundry office expenses	$106 95	
Warrants paid	651 06	
Secretary's salary	400	1,158 01
Balance cash on hand		$ 406 15

REPORT OF FINANCE COMMITTEE.

We, the committee have examined the report of the Secretary and Treasurer, and find the above report to agree with the books.

Finance Committee, { JAMES P. DONAHUE. WM. MOLIS.

THE PRESIDENT: You have heard the report, gentlemen, what will you do with it?

It was moved and seconded that it be received and referred to the Executive Committee as usual. Adopted.

THE PRESIDENT: It would be very desirable to hear the report of the Local Committee at this morning session.

MR. GEYELIN: I was appointed on the Local Committee and would state that we are to have a reception this evening at the Manufacturer's Club; Thursday, to visit Fairmount Water Works, starting after the morning meeting, and on Friday to devote the day to a visit to the Camden Iron Works and Atlantic City.

THE PRESIDENT: I think the programme a very attractive one and will be very enjoyable, but I am sorry to see that you have taken our Friday morning session away from us.

MR. GEYELIN: We thought that as so many of the gentlemen came from the interior of the country, it would be a very attractive feature of the occasion for them to visit the seashore.

THE PRESIDENT: The business of that morning session is too important to be dispensed with, even to gratify the members.

The matter is entirely in the hands of the convention. There seems to be considerable time at the disposition of the Local Committee, but can we afford to dispense with our Friday meeting.

THE SECRETARY: Mr. Geyelin, will we be home from the drive Thursday in time to have the Friday morning meeting, Thursday evening?

MR. GEYELIN: Yes, sir.

After some slight discussion it was moved that the matter be left to the Executive Committee.

THE SECRETARY: Mr. President, in this line I will say that I have an invitation from the Engineers' Club, of Philadelphia.

ENGINEERS' CLUB OF PHILADELPHIA,
HOUSE, NO. 1122 GIRARD STREET,
PHILADELPHIA, PA., April 6, 1891.

Mr. John L. Ogden, Chairman Local Com. Am. W. W. Association, Bureau of Water, Juniper & Filbert Sts., Philadelphia.

DEAR SIR:—The Board of Directors of the Engineers' Club of Philadelphia have specially directed me to extend to the members of the Association the courtesies of the Club House, No. 1122 Girard street, during their coming meeting.

Will you kindly have a copy of this communication sent to the proper officers of the American Water Works Association?

Yours truly,
HOWARD MURPHY,
Secretary.

It was moved and seconded that the courtesy of the Engineers' Club be accepted with the thanks of the convention. Adopted.

THE PRESIDENT: The Secretary is authorized to notify the gentlemen of the acceptance of the invitation and their thanks for the same.

THE PRESIDENT: I would like to inquire of Mr. Thomas Yardly if the report of the Committee on Specifications for Cast Iron Pipe, is ready?

MR. YARDLEY: Yes, sir.

THE PRESIDENT: This report is the next order of business.

MR. VERDLEY'S REPORT.

At the last meeting of the American Water Works Association, held in Chicago, in May, 1890, the chairman of this committee was invited to read a paper entitled "Specifications for Cast-Iron Coated Water Pipe:" which paper was prepared by him for the Institute of MiningEngineers, and read at their Washington meeting the previous February.

The motion of Mr. J. Nelson Tubbs, "that a committee be appointed "by this Association, of which the gentleman who read the paper just "now shall be the chairman, to report to the next convention of this "Association specifications for cast-iron pipe for the consideration of "this convention," was adopted.

Your committee now have the honor to report the result of their investigations and conclusions, and respectfully submit the same for the "consideration of this convention."

It has been the desire and aim of your committee to deal justly with both the manufacturers and the purchasers of pipe; asking nothing of the former that cannot be performed, nor requiring of the inspector any duty to which he cannot give his personal attention.

We have carefully considered the method of pipe making, as well as the present system of inspection at the foundries, and in these particulars we recommend some changes, that if adopted, will tend to secure a better quality of pipe, without entailing additional cost on the maker.

The long established practice of the engineers of the United States Army, as well as hydraulic engineers of eminence, of testing pipe iron for tensile strength, we think can be improved by the adoption of a transverse test as a more reliable method of securing the best quality of iron for pipe, as well as a nearer representation of the strain the iron must endure when under hydrostatic pressure.

Pressure exerted anywhere upon a mass of water is transmitted undiminished in all directions, and acts with the same force upon all equal surfaces, and in a direction at right angles to those surfaces.

Cast-iron pipe which appears to the eye to be sound, and of the proper form, may have one or more of the following imperfections, viz.:

First—A poor quality of iron.

Second—Shrinkage in the metal, due either to improper molding, varying thickness of the shell, or to the too rapid cooling of the melted iron.

Third—Want of uniformity in the thickness of the shell, which is usually due to a want of care, or skill, in molding.

The first trouble, poor iron, may be guarded against by the frequent taking of sample bars to be tested in the manner hereinafter specified. An inferior quality of iron will result in losses from breakage in transportation and handling, difficulty in cutting the pipe without getting split ends, or irregular breaks, and in failure of the pipe when subjected to a heavy water ram, which tests the toughness of the iron, as well as its tensile strength. When a pipe is under hydrostatic pressure at the works, there can be no water-ram, and the water is practically free of air. Neither of these conditions exist in practice; the water is not free of air in service, and the sudden closing of a valve will certainly produce a water-ram, and these blows will be repeated with greater frequency as

water motors come into more general use. There is no way provided to anticipate the call for an excess of water, and the sudden closing of a valve will most certainly endanger the pipe. As this cannot be guarded against, all we can do is to secure the best quality, and thereby reduce the chances of bursted pipe to the minimum.

The second trouble, shrinkage strains, deserves to bear by far the burden of the largest share of bad names which cast-iron has received as a structural material. This fault is inexcusable, and it will only be remedied when the consumer, by rigid inspection, insists that the metal receive the proper treatment from the time it enters the flask until it is coated and tested.

A custom has grown among pipe makers during the past few years of removing pipe from the pit before it is sufficiently cool. This is very bad foundry practice, and should not be permitted. Pipe should not be stripped and taken from the pit while showing color of heat, for the reason that, when hot pipe is exposed to a sudden chill from cold air, the shrinkage of the outer surface will induce internal strains, and pipe in such condition will be liable to give way in the trenches. Too great stress cannot be laid on this matter of cooling down. It is a waste of money to buy good iron, if it is not treated with the greatest care while cooling down from the melted state.

The hydraulic test under a high pressure, supplemented by the hammer test, is a detective on shrinkage strains. But it is a matter of record that water pipe has been made from a superior quality of tested iron; tested by the hammer under heavy hydrostatic pressure; laid in the trenches, and again tested; only to burst several months later under a pressure much less than that of either test, with no evidence of any water-ram, and no flaws to be found in the break. That pipe must have been unfairly treated in the foundry.

The third trouble is usually caused by the core being out of center. This should not be undervalued. It is not only that the pipe is too thin on one side; the worst feature is that the thin side is almost sure to cool the quicker; thus again producing the shrinking strains, which are so destructive to the strength of iron. Our present requirement of hydraulic pressure is severe enough to detect this irregularity of thickness, but the inspector should not depend on it with too much confidence. When in doubt, every pipe should be calipered.

The most reliable test we have is the test of the finished pipe by hydraulic pressure, while it is being thoroughly sounded by the hammer. The usual practice is to test every size pipe to 300 pounds pressure per square inch. This, however, may be shown to be unfair to the larger sizes of pipe. When we subject a six inch pipe, with shell one-half inch thick, to an internal hydrostatic pressure of 300 pounds per square inch, we have an average tensile strain on the metal of 1,800 pounds per square inch. If we subject a thirty-six inch pipe, with shell one and one-quarter inches thick, to the same internal pressure, we have an average tensile stress on the metal of 4,320 pounds per square inch. Accepting the bursting pressure of pipe at 16,500 pounds per square inch, as given by the best authority, "Fairbairn," the six inch pipe would have a safety factor of nine, and the thirty-six inch pipe a safety factor of about four.

As a matter of comparison, we give the diameter, thickness and

varying strains per square inch of metal under 300 and 250 pounds hydrostatic pressure, as follows:

Diameter.	Thickness.	300 lbs. pressure.	250 lbs. pressure.
6 inches	.505 inches.	1782 pounds.	1485 pounds.
8 "	.562 "	2135 "	1780 "
10 "	.619 "	2423 "	2020 "
12 "	.677 "	2659 "	2215 "
16 "	.794 "	3024 "	2519 "
20 "	.905 "	3312 "	2762 "
24 "	1.020 "	3528 "	2941 "
30 "	1.192 "	3774 "	3146 "
36 "	1.363 "	3960 "	3302 "
48 "	1.707 "	4218 "	3515 "

There is, however, a mechanical reason why the pressure on the larger pipe might be reduced to 250 pounds; namely, the fact of the difficulty of getting a water-tight joint on the large pipe when under 300 pounds pressure.

Your committee, therefore, recommend that the test pressure at the foundry be made to conform to Section 17 of these specifications.

To determine the value of wrought iron, we measure its tensile strength and its elongation. If the iron is hard and granular, it will show high tensile strength, but will be low in elongation; the best element of wrought iron.

The value of cast-iron may be determined in the same way, but its elongation is too small to be readily measured in a tensile test. The same result may be reached by measuring the deflection of a bar before breaking under a transverse test, which can be measured with accuracy.

The thickness of test bars should correspond with the thickness of the shell of the pipe it represents, and like the pipe should be cast in moulds, or dry sand, vertically, so that the test bar would in every particular represent the iron in the pipe. For several reasons this would be impracticable, and we, therefore, recommend the adoption of a bar for transverse test 26 inches long, 2 inches wide and 1 inch thick, to be loaded in the center, between supports 24 inches apart. This bar is inexpensive to the manufacturers, and can be made sufficiently accurate in dimensions to be ready for the testing machine before the pipe of which it is the representative is stripped and ready for the hydrostatic and hammer test. The inspector has full knowledge of the character of the iron, and whether the pipe be accepted or rejected, the inspection will have been made with a greater degree of intelligence than is possible under the present system of tensile tests; the results of which generally reach the inspector a day or two after the pipe has passed from his hands.

For your information we append the result of 140 test bars. Of these, 33 were the average castings; others that were selected were of the exact size, 2x1 inches. There were 33 duplicate bars cast from the same iron. These were tested for tensile strength. In addition we give the result of 37 test bars, 18 inches long, 3 inches wide and one-half inch thick. The iron from which all these bars were cast was made by and represents the average quality of irons used by the best makers of pipe. The size bar we recommend is practically the average thickness of the shell of the large diameters of pipe, and the sizes that require the greatest care in making, as well as the rigid inspection.

TABLE OF BARS 24″x2″x1″.

Width in Inches.	Thickness in Inches.	Deflection in Inches.	Transverse Load lbs.	Tensile Strength lbs.
2.	1.	.406	1850	21150
2.	1.031	.437	2050	20100
2.	1.	.312	1850	20200
2.	1.	*.281	*1440	21010
2.	1.	.375	1850	19020
2.	1.031	.406	2230	18200
2.	.750	*.250	*1310	21000
2.031	1.	.437	2200	19500
2.	1.	.437	2100	18850
2.031	1.	.375	1840	19010
2.	1.031	.437	2230	19750
2.	1.	.375	1800	21500
2.	1.031	.419	2240	19100
2.	.937	.312	1620	20000
2.	1.	.312	1850	21755
2.	1.	.312	1760	19000
2.031	.937	.437	1800	21400
2.	1.	.415	2100	20100
2.031	.987	.408	1800	19200
2.	1.	.437	1800	19400
2.	1.	.437	2020	23000
2.	1.031	.375	2260	21100
2.031	.937	.400	1880	20040
2.	1.	.437	2200	19800
2.	1.	.415	2040	21000
2.	1.031	*.245	*1520	19450
2.062	1.	.265	1795	18950
2.	1.046	.265	1800	22900
2.062	1.031	.277	2010	20250
2.	1.078	.277	1990	20000
2.031	1.031	.285	1955	21100
2.031	1.	.280	1800	18910
2.	1.	.275	1800	21650
		* defective.	* defective.	

Averave width of above ..... 2.01 inches.
" thickness of above ..... .998 "
" deflection of above ..... .358 "
" transverse strength of above ..... 1903 pounds.
" tensile " " ..... 20224 "

Selecting same number of bars, which are exactly 2″x1″, and taking an average of their deflection, and transverse and tensile strength, we have the following:

Deflection ..... .373 inches.
Transverse strength ..... 1890 pounds.
Tensile strength ..... 20531 "

TABLE OF BARS 18″x3″x½″.

WIDTH IN INCHES.	THICKNESS IN INCHES.	DEFLECTION IN INCHES.	TRANSVERSE LOAD IN POUNDS.
3.	.51	.305	1,090
3.	.55	.346	1,275
2.96	.48	.350	900
3.26	.56	.200	1,770
3.	.53	.280	1,200
3.24	.52	.200	1,480
3.	.53	.230	2,000
3.	.55	.230	1,250
3.	.55	.270	1,200
3.02	.52	.350	1,070
3.02	.52	.360	1,075
3.	.53	.310	1,200
3.	.49	.300	1,000
2.85	.50	.320	980
2.95	.50	.430	1,100
3.05	.50	.400	1,230
3.	.50	.390	1,200
3.	.50	.395	1,225
3.05	.50	.457	1,325
3.02	.50	.408	1,250
3.04	.49	.400	1,238
3.	.52	.412	1,300
3.	.51	.430	1,400
3.	.55	.388	1,400
3.	.52	.410	1,300
3.07	.52	.370	1,400
3.05	.54	.449	1,550
3.04	.54	.390	1,500
3.02	.46	.458	1,100
3.	.50	.627	1,200
3.05	.50	.395	1,300
3.06	.50	.471	1,450
3.05	.50	.457	1,400
3.	.50	.342	1,200
3.03	.49	.439	1,250
3.05	.49	.403	1,200
3.05	.50	.417	1,200

Average width of above ..... 3.02 inches
" thickness of above ..... .513 "
" deflection of above ..... .370 "
" transverse strength ..... 1,276 pounds

Selecting same number of bars which are exactly 3″x1½″ and taking an average of their deflection, and transverse strength, we have the following :

Deflection ..... .317 inches
Transverse strength ..... 1,200 pounds.

SPECIFICATIONS FOR CAST-IRON COATED WATER PIPE.

Section 1—The Pipe shall be the usual kind known as "Hub and Spigot;" each pipe shall be twelve (12) feet in length from the bottom of the hub to the end of the spigot. The form and dimensions of hub and spigot ends shall be as marked on and shown by drawings, to be furnished or approved by the purchaser.

Section 2—The metal shall be of the best quality for the purpose, made from what is commercially known as "Neutral" pig-iron, which shall have been made from iron ores without the admixture of cinder, and when cast into pipe, the metal shall be tough, and of such density and texture as will permit of its being easily cut and drilled by hand.

Section 3—Each pipe shall have cast on its exterior surface in raised Roman letters, one and a half (1½″) inches long, and shall be further marked in like manner with letters and figures to designate the maker of the pipe, and the year; also serial numbers shall be cast on each pipe, commencing with a number to be designated by the purchaser.

Section 4—The pipe shall be cast in dry sand molds, or flasks, placed vertically, and shall be of the several diameters named in the contract.

Section 5—The shell shall be smooth and sound, without cold-shuts, lumps, swells, scales, blisters, sand-holes, or other imperfections; truly cylindrical; of full diameters, and with interior and exterior surfaces concentric.

Section 6—The shell shall be of uniform thickness throughout its entire length. Should the Inspector find in any one place a variation in thickness of more than ten (10) per cent., either greater or less, from that specified in the contract, such pipe shall be rejected.

Section 7—Should the Inspector have cause to believe that pig-iron with "an admixture of cinder" was being used, all pipe from such iron shall be rejected until satisfactory evidence to the contrary shall have been furnished.

Section 8—Test bars shall be cast as often as the Inspector may deem necessary for his information, and if the tests do not come up to the requirements of Section 10, all pipe made from such iron shall be rejected.

Section 9—Test bars shall be taken as required by Section 8, and shall be twenty-six (26″) inches long, two (2″) inches wide, and one (1″) inch thick.

Section 10—Those bars shall be tested for transverse strength when loaded in the centre, twenty-four (24″) inches between supports (narrow sides vertical), and shall carry a centre breaking load of not less than nineteen hundred (1900) pounds, and show a deflection of not less than twenty-five one hundredths (.25) of an inch before breaking.

Section 11—These bars shall be cast as near as possible to the specified dimensions, without finishing up; but corrections shall be made for variation of width and thickness; and the corrected result must conform to the above requirements.

Section 12—Pipe shall not be stripped and taken from the pit while showing color of heat.

Section 13—Pipe shall be thoroughly cleaned, both inside and outside, without the use of acid, or other liquid.

Section 14—When the pipe is so cleaned, it shall be heated to 300 degrees Fahrenheit, and immersed in a bath of coal-pitch varnish of an equeal temperature.

Section 15—When the pipe is removed from the bath, the coating shall *fume freely*, and set perfectly hard within one hour from the time of its removal.

Section 16—No pipe shall be tested by hydrostatic pressure until the varnish has become hard.

Section 17—When coated, the pipe shall be subjected to a test by hydrostatic pressure of not less than three hundred (300) pounds per square inch for all pipe 12 inches in diameter, and under, and two hundred and fifty (250) pounds per square inch for all sizes above 12 inch; and while under such pressure, the pipe shall be subjected to an additional test by a series of blows at various points throughout its entire length, with a three (3) pound hammer, attached to a handle sixteen (16) inches long. If any failure is shown in the pipe during this test, it shall be rejected.

Section 18—The maker shall furnish to the Inspector two wrought iron rings (male and female templates), the one showing the outside diameter of the spigot end, and the other the inside diameter of the hub end of each size pipe; and the said pipe, with the proper allowance for diameters, shall conform to the respective templates.

Section 19—The weight of each pipe must correspond as nearly as possible to the standard named. Any pipe which may fall short over (3) per cent. of the standard weight which shall be rejected, and no pipe shall be allowed or paid for, that shall exceed three (3) per cent of the standard weight. These requirements shall be determined by the weight of each pipe separately.

Section 20—All appliances necessary for the Inspector to carry out the requirements of these Specifications shall be furnished by the maker, free of charge to the purchaser.

All of which is respectfully submitted.

S. Bent Russell,
A. J. Guilford, } Committee.
T. W. Yerdly,
Chairman.

The President: You have heard this report, gentlemen; what will you do with it; it is open for discussion.

The Secretary: Mr. President, as there seems to be no discussion on this report, I offer the following resolution:

Resolved, That it is the sense of this convention that the form of specifications for cast iron pipe reported by this committee is the proper and correct form to use in all proposals for cast iron water pipe.

The resolution was seconded and adopted unanimously.

The President: The next order of business, gentlemen, would naturally be the report of the committee on Vegetable and Animal Growths affecting water supplies, of which Dr. Leeds is chairman, but the time for our adjournment being so near at hand and the value of Dr

Leeds' communications so well known to us, I think we had better save them for this afternoon.

MR. DECKER: I wish to introduce to you Mr. S. G. Steinitz, of the New England Water Works Association, and I move you, sir, that he be accorded the courtesy of the Association during his stay in the city.

THE PRESIDENT: Mr. Steinitz will receive from us all the courtesies in our power to bestow.

MR. STEINITZ: I am very glad to meet the members of the American Water Works Association ; I can assure you that we take great pride in our water works at Pawtucket. I am assured that Mr. Darling will be here during your session. Events compel me to leave the city to-morrow, or I would be with you here, as I always take a deep interest in water works affairs. I thank you most kindly, gentlemen, for the public recognition you have extended me.

THE PRESIDENT: I am sure all are glad of the prospect of seeing Mr. Darling.

Has any gentlemen any matter out of the regular order which he desires to have considered by the convention and which can be considered during the next ten or fifteen minutes ?

Mr. Geyelin has a paper on the Growth of the Philadelphia Water Works which I presume is mostly historical, and if he has it with him I think the time of the convention could very well be taken up with it.

PHILADELPHIA, February, 1891.

Members and Associates of the American Water Works Association :

GENTLEMEN—As a resident of Philadelphia and member of your Association, having also, to a slight degree, been associated with the development of the water works of this city, I have been asked to make a few remarks before you, as to the growth of these works, and to point out to you such work as will merit your inspection while here.

Philadelphia, like most of the other cities of this blessed land, has been phenomenally rapid in its growth, and from its earliest days, after the pump-handle era, the man at the head of the Water Department in this city, as nearly everywhere else, has had the greatest difficulties to meet. To few, indeed, has been the lot whose nights were not disturbed by threatened water famine or floods.

It is hardly more than the span of two generations since the first steps were taken by the citizens of Philadelphia to supply themselves with water, to be pumped into an elevated tank by steam, and it stands

on record as one of the first—if not the first. It is even within the memory of many men now living, who on the 27th day of January, 1801, might have seen the then great steam works on the banks of the Schuylkill, and those in the then known as Centre Square (now the court yard of our public building), dividing the labor to pump at the rate of nine hundred thousand gallons per day, and force that water into a tank placed fifty feet above the latter engine.

Many an engineer, now resting on his labors, no doubt can look back, who, when young, visited this city to study its water works. Philadelphia then held the title of the Mecca of the hydraulic engineer, and even now where is the city that can point out a greater variety of pumping engines? Here can be studied engines using water and steam as the prime motor; the altitudes to which water is pumped varies, also, from ninety-six to three hundred and sixty feet, with various stages between these extremes.

Though Philadelphia cannot point out to you such gigantic works as the great in-take of water from the lake, which you saw in Chicago, nor can Philadelphia point out to you an aqueduct like the noble Croton Aqueduct that supplies the city of New York with water, yet so varied is the field hydraulic engineering embraces, that volumes might be written of what has been accomplished here alone. Let us and our descendants forever cherish the name of B. H. Latrobe, who planned the first steam works of the land, also that of his coadjutor, Nicholas Rosevelt, who was bold enough to construct these works and guarantee their performance for five years.

Calling to mind the vast embodiment of mechanical skill in the great pumping engines of a Worthington, a Gaskill or a Levitt, specimens of most of which may be found in this city, or looking at the huge street mains of four and more feet in diameter, and the efficient tools, such as large boring mills, hydraulic cranes, etc., in the control of their makers, it is hard to realize the difficulties these pioneers, Latrobe and Rosevelt, had to overcome. Think of it. Wooden tanks had to serve as boilers to raise the steam; wooden shafts and beams had to serve them as connecting rods, and wooden stops and pipes were used for their ascending and distributing service. Over six years after the works of Latrobe and Rosevelt were started, that is in 1807, the successful forging of a piston rod of four inches in diameter and ten feet long, was deemed of sufficient importance to be noticed in the annual report of the Water Department.

We can imagine the amount of pounding these engines must have withstood when it was only in 1810 that the first air vessel was applied. Speaking of an air vessel, permit me to anticipate the course of events by stating that as late as 1853 it was the custom at the Fairmount Works to draw the water from the pumps on Sundays for the purpose of filling the air vessels with air, which had to last the pumps for a week.

Thinking that some members might desire to see these relics of early engineering, I have, through the kindness of the present Chief of the Water Department, Mr. John L. Ogden, obtained these specimens for your inspection.

With the growth of this city these works soon became too small, when in September, 1815, a steam pumping works of 1,700,000 gallons capacity was started, pumping water to the top of the Fairmount Hill, at the foot of which the works were located. In the year 1817

these works were again increased, this time by one of the boldest departures in steam engineering, namely, by steam boilers and pumps, the former working under the great pressure of two hundred pounds to the square inch. This was done by the renowned pioneer in American mechanics, Oliver Evans.

What a step was his from the wooden boilers of 1801 to a pressure the engineer of this day considers hardly within the limits of prudence. The capacity of the Oliver Evans pumps was 2,300,000 gallons per day. Many, no doubt, amongst you gentlemen will recall with just pride the name of Frederic Graff; let his name forever be honored for his great work in the creating of the Fairmount Water Works, which were started in 1822. They consisted of a crib dam about 13 feet high, over 1,250 feet in length, forming the Fairmount Pool, from which the water was taken to eight breast wheels, varying in diameter from 16 to 18 feet; all of these wheels were 15 feet wide; each wheel had attached to the shaft a pair of double-acting pumps, 16-inch diameter, with strokes varying from 4½ to 6 feet. The coadjutors on this work were first Arial Cooley, of Chicopee, the maker of the dam; the firm of Rush Mechlenberg, the maker of the machinery, and Drury Bromley, the maker of the mill work. These men did their work well. Especially should attention be drawn to the dam constructed by Arial Cooley, which withstood many floods without the displacement of a timber. Early this pool at Fairmount became the source of health and pleasure to the young. The picturesque surroundings, now forever to be preserved as part of the Fairmount Park, will always make this spot dear to our people. It was left to Mr. Graeff's son and namesake and his successors, Messrs. Ogden, Birkenbine, Cassin, McFadden, Ludlow, and Ogden to first replace the breast wheels with turbines and enlarge the pumps. The result of these alterations is that as much as 43,000,000 gallons have been pumped per day, and the greater part to nearly double the height of the Fairmount Hill. When we read for 1859 of 5,000,000 gallons daily pumpage, and eight times that amount last year, credit is due to all.

Referring again to Cooley's dam, I ought to say that in 1872 the younger Fred. Graeff placed a new dam in front of the former, both of which seem to promise a long life. What I have thus far said refers to the old city of Philadelphia, as incorporated by William Penn, namely, the district between Vine and South streets, the river Delaware and the Schuylkill. Districts surrounding the old city, however, felt the need of water works. Northern Liberty and Spring Garden, the ground of which mainly lies higher than what Fairmount Basin could supply, had as early as 1844 their own water works on the Schuylkill above the Fairmount dam. The engines were under the direction of Mr. William E. Morris, made by the Messrs. Merrick. These engines are highly spoken of by Engineer Birkenbine. In the year 1854, however, Philadelphia felt the need of expanding. It took within its wings the balance of Philadelphia county, largely increased the Spring Garden station, until now the daily capacity of these works reaches over 96,000,000 gallons per twenty-four hours. Philadelphia has, in addition, three other pumping stations, namely, the one supplying the whole of the city, west of the Schuylkill, known as the Belmont Works; the Shawmont station, supplying the high ground of Roxborough and Germantown; finally, the Lardner Point station, supplying the northeastern district. The total

capacity of these works is about 200,000,000 gallons per twenty-four hours, and the amount actually pumped during certain days of last July exceeded 170,000,000 gallons.

While Philadelphia is rapidly approaching the danger point as to quantity, it behooves any one speaking of the quality of the water pumped here, to approach the subject carefully. Who has not read of the so-called horrible Schuylkill water? Some of you may have seen pictures gotten up by parties who have filters to sell, representing the Schuylkill river having on its banks a half a dozen towns emptying their sewage into its bosom. There are numerous doctors with all sorts of projects ready to sacrifice themselves, to come to the princely moribund's assistance, by giving this good city other waters. It would be rather surprising were it otherwise, when you consider this fast growing patient possessor of over two and a quarter million dollars annual revenue.

But, let me assure you, that the case is not half so desperate as it is in some quarters represented. Great improvements have been made within the last few years in keeping foreign matters out and away from its banks. There is yet a good deal to be done in this direction, no doubt. Still, when by actual analysis made in December, 1890, a competent chemist reports an average of only 9.66 grains in a gallon of the Schuylkill water, taken from four different localities in this city above the Fairmount dam, and these grains to be mainly of a vegetable character, the case of this moribund is, certainly, not a desperate one. Again, let me add, that through the persistent will of the late head of our city government, a great storage reservoir of about 800,000,000 gallons capacity, was recently completed. This great work, with the Fairmount works and the Spring Garden works, merits your visit. Strange, indeed, would it be, were you not to admire this picturesque pool, from which three of the pumping stations draw their water, or if you failed to notice the elegant construction of these works. You will, I trust, approve the policy of our Water Department, notwithstanding the huge cry against it, in continuing the use of these works, at the same time, either by filterage or more reservoirs, pump clear water only, to be supplemented at no distant day by an efficient system of intercepting organic matter.

This huge reservoir stands as a monument to the projector of it, and in part maker of it, Mr. Frederic Graeff, the son of the founder of the Fairmount Water Works: and not less should it stand as a monument to the heads of the different departments, as well as to the contractors who had the finishing of it. Other reservoirs are in course of preparation, which will still more enable the pumpage to be stopped while the waters are turbid.

I will now close, gentlemen, by stating, that while in this good City of Brotherly Love, you may be called upon to drink something more spirituous than Schuylkill water—Well and good; but let not the bad report of the filter men and doctors I have just mentioned deter you from using the Schuylkill water freely. Take the word of one who has drank it (though not exclusively), for over forty years, that when taken with moderation it will do no harm.

EMILE GEYELIN.

THE PRESIDENT: If the members of the convention are to see the water works of which Mr. Geyelin has

just given us a description, I am sure his paper would greatly assist us. I would like to ask Mr. Geyelin whether he meant to say that there were any specimens of the primitive method that was first adopted.

MR. GEYELIN: There are some, Mr. President. In the last few years the office of the department has been moved and some of them have been lost.

THE PRESIDENT: Will you explain to me how steam was generated in a wooden boiler.

MR. GEYELIN: The boiler was made of three-inch pine plank, secured with braces and stay bolts; it was square, nine feet by nine feet, and fourteen feet long; the fire was made in a cast-iron box placed inside, the heat passing through flues placed inside the wooden tank. The pressure was low, from two and one-half to four pounds to the square inch. I saw sections of it about twenty-five years ago.

THE PRESIDENT: The time for adjournment has arrived. If there is no objection, the meeting will stand adjourned.

MR. GARDNER: Mr. President, I would like to suggest the propriety of determining, before the question assumes an aspect of a personal character, whether the Association shall continue upon its roll of *active* membership those who, owing to a change in their business or professional relations, would not now be eligible to *active* membership. I therefore move that the Executive Committee be instructed to consider a report upon the status of members whose relations have been thus changed.

MR. MILNE: I presume the idea of the author of the motion is to have the Executive Committee take a little time to consider the question, and to present some intelligent view, which possibly might not be so readily reached by the convention in a general discussion. I can see the importance of the proposition. I believe there would be no harm in referring it to the Executive Committee, and having the committee determine upon the propriety of making some recommendation upon it to the convention.

THE PRESIDENT: Is it contemplated that the action of the committee shall be binding upon the convention, or final?

MR. GARDNER: The purpose is that the Executive Committee, without any bias whatever, shall consider the necessity for a change as proposed, make a report upon it, and then leave it to the convention to discuss and decide upon the report.

Upon motion Mr. Gardner's resolution was adopted.

MR. GARDNER: I would like to have a report on the subject at the earliest convenience of the committee.

THE SECRETARY: The Executive Committee will please meet in room 20 immediately after the close of this session to consider this and other matters.

THE PRESIDENT: As the hour for adjournment is now passed the convention will adjourn to meet at 2:30 this afternoon.

AFTERNOON SESSION,—2:30 P. M.

The meeting was called to order by President Bull, who stated that Mr. John L. Ogden, Chairman of the Local Committee, had something to say to the delegates.

MR. OGDEN: Mr. Chairman and gentlemen of the Convention: The Local Committee of Arrangements were informed by the General Committee that the American Society of Water Works Engineers met for business—not pleasure, and our arrangements for their entertainment have been made with that end in view. We propose to have a reception at the Manufacturers' Club this evening. The Director of Public Works will be present. On Thursday we will show you to some of the Water Works of the city, and on Friday will take you to Atlantic City. Philadelphia is fortunate to be favored with the presence of such a body of men, and I beg, gentlemen, to welcome you at this time to Philadelphia.

Edwin S. Stuart, Mayor of Philadelphia, was then introduced to the meeting, and spoke as follows :

Mayor Stuart : Mr. Chairman and gentlemen : I feel as if I owe an apology on behalf of the city for not being present at the opening session, but it was through no fault of mine. I feel that I am about to address a body of men, who, perhaps more than any other body of scientific men, are directly interested in matters which concern the health of the entire community. This city will soon have to consider seriously the question of a water supply adequate to our needs. We have as yet, I know, no such comprehensive system of water works as have some other cities. We have, I believe, the largest single water works plant in the country. I myself have been in office just one week, so the burden of responsibility for any deficiency cannot be laid on my shoulders. I bid you a hearty welcome to the City of Brotherly Love, and I myself, for the benefit of the administration hope that I may be able to do something or find out something that may benefit the water supply of the city and I extend to you as a body or as individuals, a cordial invitation to visit me at my office.

I have nothing more to say, Mr. Chairman, than that I thank you for the honor conferred upon me, and wish the convention success.

The President : I think we can all feel flattered, gentlemen, that the Mayor of the City can consider our advent of sufficient importance to come here to meet us, and while we are pleased to listen to such cordial words from a man in his position, yet I don't know that we can give the board of public works or the water department any information that will be of special service to them. I note that they have been in the business for ninety years ; only a few of us have been in business for as long a period of time as that covers, and I question whether we may presume to instruct these gentlemen. It will give us a great deal of satisfaction to inspect the works of a century, which he has spoken of. Once more we thank you for your presence and your welcome.

Mayor Stuart : I would ask the convention to

excuse me, as I have important public business which demands my attention.

THE PRESIDENT: The first business on hand is the report of the Executive Committee, that is to say, the report of the meeting held since we adjourned at noon.

REPORT OF EXECUTIVE COMMITTEE.

To the Members of the American Water Works Association,

GENTLEMEN: Your Executive Committee would respectfully report:

That they have fixed the salary of the Secretary and Treasurer at $400.00 for the past year, and have authorized him to draw a warrant for that amount.

We would recommend that all members delinquent in their dues for three or more years be served by the Secretary with a final notice, and that if they do not respond in a reasonable length of time their names be dropped from the roll, with privilege of reinstatement at any time upon payment of all arrearages.

Respectfully submitted,
W. B. BULL, Prest. for Executive Com.

THE PRESIDENT: If there is no objection the report will stand as approved. The report was then adopted.

THE PRESIDENT: The first regular business will be the report of the Committee on Vegetable and Animal growths, Professor Leeds chairman.

REPORT OF THE COMMITTEE ON ANIMAL AND VEGETABLE GROWTHS AFFECTING WATER SUPPLIES.

L. J. LeConte, Oakland, Cal.; L. H. Gardner, New Orleans, La.; Albert R. Leeds, Hoboken, N. J., Chairman.

The committee is not able to make other than a partial report at the present time, setting forth what progress it has made during the past year.

Immediately after the last annual meeting, a circular was issued by the Secretary of the Association, inviting the co-operation of our members, and requesting them to send such observations as they had made, such suggestions as to causes, treatment and remedies as they could, and when advisable samples of the vegetable and animal organisms and of the waters affected in their tastes and odors by the same.

The responses were few in number. The information they contained has been embodied in the report. Some twelve samples of water were sent and were analyzed. Curiously enough, none of the waters sent

were of a character to throw any light upon the labors of the committee.

At the invitation of Mr. Geo W. Rafter and Mr. Alphonse Fteley, the members of a committee with like objects, appointed by the Society of Civil Engineers, several joint meetings have been held for the purpose of mutual assistance. These conferences brought prominently into view the magnitude and difficulty of the investigation, and the necessity of formulating some plan by which its expenses should not fall entirely upon the members of the committee. As yet, however, no such plan has been submitted, and the committees have done what they could afford by individual outlay and effort.

Our labor includes a summary of our knowledge up to date. This is tabulated under the various headings of "Locality," "Source of Water Supply," "Dates of Appearances of Tastes and Odors, their Supposed Origin, the History of their Appearance, Continuance and Disappearance and Finally the Remedies which have been Tried or Suggested."

One of the earliest cases in which an attempt was made to discover the origin of offensive taste, was that of Boston in 1851, three years after the introduction of water from Lake Cochituate in 1848. The consumers complained that the water as drawn from the service pipes had a bad taste, and the suggested remedy of flushing the main appearing to have afforded relief, the origin of thetrouble was supposed to have been in the distribution system. But in the subsequent trouble of October, 1854 and February, 1855, this explanation was entirely laid aside by Prof. Horsford and Dr. Jackson, who found that while the dead ends frequently contained stagnant and impure water, yet the water at the same time in the larger pipes with rapid current was offensive. They ascribed it entirely to the fermentation of vegetable matter derived from acquatic organisms originating in the marshes and bogs draining into the lake, and though according to some observers the taste was that of fish, its origin was in no wise connected with animal putrefaction, but was exclusively vegetable.

The "cucumber" or "fishy" taste again occurred in 1874 and 1875, this time in the Bradlee Basin. Profs. Nichols, Farlow and Burgess reported that it was not due to any discoverable plants or animals, either living or decaying. But in the following year, they ascribed the "pig-pen" odor which affected the water in Horn Pond to the growth of an alga belonging to the family of Nostoclaceæ, the Anabaena Gigantea, and to the Plectonema which afforded a favorable starting point for the growth of the former. They advised the extirpation and removal of the plectonema.

As throwing light upon the habits of this species of anabaena, it is to be noted that Dr. Wood, who in 1869 discovered and named it, says that he found it, "late in the summer, floating upon a brick-pond below the city, forming a part of a thick, dirty-green, pea-soup colored, almost pulverulent scum. The filaments, though occasionally in great numbers, were never, that I saw, joined together by any jelly so as to form a pond." Its home is in stagnant waters.

The Plectonema belongs to the same family, but its usual habitat is in limestone springs, forming dark green tufts one-quarter to one inch in length attached to submerged plants, wood and stones.

The important part of these observations, which is available for general service, is not that of the removal of the anabaena, but the remo-

val of the causes which led to the stagnant condition of the water, essential to its rapid growth and development. It is an unfortunate outlay of money and energy to extirpate particular plants from water supplies, and allow the conditions which led to their appearance, to continue.

Five years later when a similar trouble occurred in Farm Pond, it was ascribed not to the anabaena, but by Prof. Remsen, to a certain species of fresh-water sponge, the Spongilla fluriabilis. Up to that time the sponges had not been regarded as the source of offensive odors, since they grow best in moving waters, and are very frequently formed in rapid-running waters growing on the under sides of the timbers used in and about the gates and conduits of water works forebays. They thrive best in these localities because they are themselves fixed to the surfaces on which they grow, and obtain their food from the moving water by propelling it through the fine pores which traverse their structure, and then after assimilating the microscopic organisms upon which they feed, expelling the water and the excreta through the larger openings or mouths. If the supply of this food is cut off, or if their pores are choked by deposit of mud they speedily die.

A very valuable experiment in this connection is narrated by Mr. G. H. Parker in the recent report on Water Supply of the Massachusetts State Board of Health, whereby the death of the sponge (the Tubella Pennsylvania) which was found in the principal mains of the Boston supply system, was readily brought about by removing the algae and other organisms by filtration. He draws from his experiments the important conclusion that, not only sponges but all the animals which inhabit the pipes are dependent for their food upon the organisms carried into the pipes by the water, and that if these be filtered out, the gain would not only be in the removal of the organisms themselves, but a disappearance of sponges and other animal growths from the water supply.

The mode of growth and feeding of the sponge is such that eminent specialists in the study of Spongillidæ found it difficult to believe that it alone could have originated the unusually offensive condition of Farm Pond at that time. But Prof. Farlow emphatically states that the only other organism which was present at the same time, and which possibly could have originated the odor, the Aphanothece prasina, a dark-bluish green alga forming roundish gelatinous masses, and belonging to the family of Chroococcaceæ, did not give off the odor.

It is worthy of note that these gelatinous masses af Aphanothece are associated with more or less stagnant conditions of the water. In a preceding year Farm Pond had been troubled with the growth of anabaena, another plant growing in stagnant waters. This condition of stagnation is of much more importance in studying the troubles affecting this particular body of water than the growth of the sponge and its decay. For the sponge flourishes best in rapidly-moving waters, growing usually downward so that its pores shall have opportunity to take in sufficient micro-organisms for their food without being choked by them, or by deposit of mud, or by such gelatinous masses as those above referred to. So long as it is assimilating these organisms it is acting as a purifier. And ordinarily it appears to pass through its period of development arriving at its maximum growth at the same season as the organisms which are its food, that is in the months of July and August, and then to die down

without affecting the taste and odor of the water. And when it does so affect the odor, the conditions would appear to be similar to those characterizing stagnating waters, with excessive growth of organisms found therein. If these conditions are reversed and by movement and circulation the development of stagnant water jellies, etc., is prevented, the trouble is attacked in its causation, and not in its consequences, as it is when the grubbing up and extirpation of the anabaena, the sponges, etc., is attempted by way of remedy.

The Hemlock lake water supplied to the city of Rochester is of great purity, but it has at times acquired a strongly fishy taste and odor. At the first occurrence in 1876, the cause was ascribed to algæ, without identification of the specific form, but in the later trouble in September, 1888, its origin was traced by George W. Rafter, C. E., to the sudden development of a vast quantity of greenish, spherical unicellular alga, the Volvox Globator. That it was due to the volvox was proven by filtering off this alga and showing that the volatile matter causing the fishy taste and odor could be expelled from the filtered water by heating, while the volvox detained on the filter paper could be made to communicate the same taste even to distilled water used in washing it off the filter.

The same gentleman showed that the fishy taste and odor affecting the same water in May of the following year, was due not to algæ, but to two of the diatomaceæ, the encyonema and cocconema. He computed that the gelatinous masses accompanying the diatomaceous growth occupied a number of hundred cubic yards. The breaking up and disappearance of these gelatinous masses was brought about by very heavy winds prevailing for thirty-six hours.

In the month of August, 1884, the water in the impounding reservoir at Hoboken during the course of a few hours became covered with a thick coating of bluish-green algæ. The water as pumped from the Hackensack River was of its usually good quality, and the trouble was remedied by pumping as much air into the seventeen mile rising main as the water would absorb at that particular temperature. As this experience is well known, it needed only be added here that the algæ did not again make their appearance in the reservoir until the summer of 1888, during a long-continued season of very hot weather with little movement of the lifeless sultry atmosphere. The walls of the reservoir, which holds seventeen million gallons rise some eight or ten feet above the level of the impounded water when drawn down as it is by warm weather consumption. An analysis of the ærated water as it flowed into the reservoir, showed it to contain sufficient oxygen and to be otherwise satisfactory. At the opposite corner, when patches of algæ made their appearance, the oxygen was notably less in amount and the ammonia considerably increased. An air-pipe with rose jets was carried around the sides of the reservoir near the bottom, which now presents during warm weather the appearance of a boiling spring. There has been no growth of algæ since this has been done.

A very rapid development of algæ and the development of a most offensive odor may take place even in spring water of great purity under certain conditions. This was the case with the water of Sand Spring, N. J., during a prolonged season of intensely hot weather in June, 1890. This water issued from a number of springs in the bottom

of a large reservoir partly covered with sand and partly with clay, and filled the reservoir to the depth of about seven feet. The water, as it issued into the reservoir, had the following composition :

Ammonia	0.0038	grains	per	gallon
Albumenoid ammonia	0.0056	"	"	"
Oxygen required to oxidize organic matters	0.044	"	"	"
Nitrites	0.0011	"	"	"
Nitrates	0.0204	"	"	"
Chlorine	0.11	"	"	"
Total hardness	2.70	"	"	"
Permanent hardness	0.22	"	"	"
Temporary hardness	2.48	"	"	"
Total solids	4.08	"	"	"
Mineral matter	3.61	"	"	"
Organic and volatile matters	0.47	"	"	"
Carbonic acid gas dissolved in 1 liter	0.61	cubic	centimeters	
Oxygen dissolved in 1 liter	7.55	"	"	
Nitrogen dissolved in 1 liter	15.10	"	"	
Total gases dissolved in 1 liter	23.26	"	"	

The algæ belonging to the genus Cladophora covered nearly the entire bottom of the reservoir. The fish with which the reservoir was plentifully stocked were dying, but their death had nothing to do with the odor which was not in any degree of a fishy character, but resembled that of some peculiarly disgusting excrementitious matter. The jars in which the specimens were transported to my laboratory gave off this odor so offensively as to produce violent nausea whenever opened. It was thought that a volatile principle might be isolated by process of distillation, or by extraction with ether, but the experiments were unsuccessful. No oil came off from the distillation, and the etherial extract on evaporation left a bright green residue in which the unbearable stench appeared concentrated. But on exposure to air this odor disappeared, and nothing tangible was left to work upon.

At my recommendation the water was pumped out of the reservoir, becoming more offensive in character as the bottom was approached. The dissolved carbonic acid due to the decomposing vegetable growth, also rose from 0.61 to 5.78 cubic centimeters per liter. Finally when the bottom was uncovered, the superficial layer of clay with the algæ covering it was scraped off and removed. Then a couple of barrels of caustic lime was scattered broadcast and this again covered to the depth of an inch with sand. Pumping was then discontinued when the water quickly filled the reservoir and permanently retained its former spring like purity and sweetness.

From preceding experiments I had been impressed with the inhibitory action of caustic lime in preventing the development of micro-organism in culture experiments, and thought it worth while to try the experiment on a larger scale in this instance. According to Richard and Chantemesse its action is more energetic than either, corrosive sublimate or chloride of lime, and according to Liborius, the presence of 4.3 grains of caustic lime to the gallon effectively destroys the typhoid bacillus. Its cheapness makes it available for water purification, and I had previously advised its use for treatment of the water of a mountain stream that was imponded in three small reservoirs before delivery to customers, and which

had fishy odor, possibly connected with the development of the abundant infusorial life that was present. The odor disappeared after the use of the lime, but whether in consequence of its use I am not prepared to state.

The development of a strong fishy smell together with the presence of infusoriæ in great abundance has been noted by Prof. Conn in the case of the water supply of Middletown, Conn., in June, 1889. He experienced some difficulty in tracing the malady to its cause, inasmuch as the jelly-like masses formed of the individual colonies of the infusorian (uroglena volvox) were so readily broken up by movement that he failed to recognize them as the origin of the dificulty when the water had passed into the distributing system, but on visiting the reservoir at a time when its surface was not disturbed by wind he found the uroglena aggregated in abundant gelatinous masses.

In Berlin, Germany, great trouble has been experienced in that part of the city supply derived from wells on account of the rapid growth of the iron-secreting alga, the Crenothix polyspora. This water is pumped directly from the wells into covered reservoirs and thence into the mains without contact with light or air. Moreover such contact is not essential since the plant was found to be present in the water of driven wells at a depth of seventy-five feet below the surface. The same plant was enormously developed in the driven well water supplied to the city of Jamestown, N. Y., in the summer of 1886, and was the cause of the offensive taste of the water in the pipes. This was the case both when partial exposure to air and light in the pump-well was permitted and afterwards when the pump-well was covered to exclude light though not air. But the many researches made in this country since that time all point to the conclusion that some other method than exclusion of light and air is needed to prevent the development of Crenothix. Artificial æration and filtration have been suggested, but it must be remembered that well water is naturally filtered water and that any process of filtration must be more perfect than the latter to achieve the result. When we bear in mind that one of the most striking characters of Crenothix is its function of secreting iron from the water in which it grows, and that iron will not exist in solution in water rendered alkaline by lime, especially if the iron protacarbonate or other compound is preoxidized by the use of air, it is possible that a treatment involving the use of both lime and air might be a step in the right direction.

Since writing the above, I have encountered the following statement of the successful use of air alone :

Æration is stated to have been completely successful in getting rid of the Crenothix present in the water supply of Konisberg, Prussia, together with much of the iron salts which amounted to four parts per 100,000, a quantity so large as to render the water before treatment unfit for washing and similar household purposes. Originally the water was conveyed by an iron main a distance of twelve kilometers. No improvement resulted from allowing it to rest in reservoirs before admitting it into iron mains. It was then turned out of the supply-main into an ancient water-course, and after flowing eight kilometers passed on to filter-beds. When first turned into the water-course the Crenothix clouded water gives a red deposit which becomes smaller in quantity, finally disappearing entirely and leaving the water not only bright, but so free that it remains for weeks in an open vessel entirely free from these growths.*

Much light could be thrown upon the subject by the study of the water in reservoirs and storage basins considered as gigantic aquaria, and

*Engineering and Building Record, vol. 21, page 131.

by the endeavor to bring about a balance between the numbers and kinds of vegetable and animal organisms so that they might best assist each other in the æration and purification of the water. If such a balance is preserved there may be a great multiplication of living forms and a very considerable amount of dissolved organic matter, and yet the water may remain odorless and sweet. To illustrate this point I shall give the history of an aquarium with glass bottom and sides, which was filled with Croton water by Mr. Mark Samuels, the aquarist, September of last year, and then maintained in a very flourishing condition to the present time, (nine months.) It originally contained nine gallons, but the water lost by evaporation was only partially replenished, none being added during the latter two months, so that at the time the analysis was made, the quantity had diminished to seven gallons. The growing plants were such as excrete oxygen freely, so that the water should be well ærated. They were six of the Sagittaria Natus, one Aponogelon Distachyon, one Cabomba, two Ludwigi, one Millfoil Myriophyllum Spicatum and three floating plants, the Salvinia Nataus. The animal organisms visible to the eye were two gold-fish, two small frogs, tad-poles and fifteen snails, the Linnea Planorbis. The large number of snails was in order to consume the decayed leaves and vegetation, which had become too vigorous from excess of light on all the sides of the aquarium. But of the fifteen, twelve had been added ten days prior to making the analysis, and ordinarily three snails are sufficient to do the scavenging in an aquarium such as above described. The water after supporting all this crowded life for nine months had a slight taste and odor of organic matter, but was in nowise unpleasant. It contained :

Free ammonia	0.007	grains	per	gallon
Albumenoid ammonia	0.029	"	"	"
Oxygen required to oxidize organic matters	0.452	"	"	"
Nitrites	0.002	"	"	"
Nitrates (N_2O)	0.544	"	"	"
Chlorine	4.89	"	"	"
Temporary hardness	9.04	"	"	"
Permanent hardness	3.26	"	"	"
Total	12.30	"	"	"
Total solids	25.21	"	"	"
Mineral matter	21.36	"	"	"
Organic and volatile matters	3.85	"	"	"
Oxygen dissolved in one liter	4.93	cubic	centimeters	
Carbonic acid dissolved in one liter	1.93	"	"	
Nitrogen dissolved in one liter	11.61	"	"	

During this great length of time the mineral matters had increased by condensation and evaporation nearly seven times more than at the beginning, while the organic matters had scarcely doubled. Moreover the deficiency in oxygen and the excess in carbonic acid, were not more marked in this small vessel of perfectly tranquil water than I have frequently noted in running streams in the months of August and September.

What is possible on this small scale, can be done on a large, vigorous fishes and aquatic grasses and plants being brought in to supplement the labors of the smaller organisms. In this connection I would refer to the letter (c) in the appendix from Mr. Charles Eliot, who states that by con-

structing a raft from the middle point of which the water of large shallow reservoirs is taken into the main, the growth of vegetation in the shade below the raft is prevented, while the fish that congregate below it eat up all the animalculæ.

I shall not add more to this report, which is really one of progress only. The tables in which an attempt has been made to summarize the localities, causes and remedies, proposed and tried, of water supplies affected with offensive tastes and odors, will be left for a future publication. The other members of the committee have rendered such assistance as their far distant residence would permit, and for the many deficiencies in this preliminary report the writer only is responsible. The valuable communication of Mr. LeConte, which enlarges on the comparative neglect of the study of the animal organisms as factors in the problem, is appended (A) ; and also that of Mr. Gardner, which describes the effect of agitation and movement upon vegetable growths in reservoirs. (B.) Finally that of Mr. J. C. Hancock, of Springfield, Mass., as exhibiting the character of communication which it is desirable to receive in the progress of the present work. (D.)

Mr. Woodruf: I want to ask Professor Leeds whether he ever came in contact with ponds which had a moss growth at the bottom in such quantities as to put forth a vegetable matter and form a scum. We have a pond at Bridgeton in that condition and that moss will grow up to a depth of five or six feet from the bottom and come up to the top of the water and when it changes life in the fall of the year will spoil the water and give a musty taste and smell, and form a green scum. I suppose that is what you call algae ?

Mr. Leeds : Possibly, yes.

SOME FACTS AND CONCLUSIONS BEARING UPON THE RELATIONS EXISTING BETWEEN VEGETABLE AND ANIMAL GROWTHS AND OFFENSIVE TASTES AND ODORS IN CERTAIN WATER SUPPLIES—BY L. J. LECONTE, C. E., OAKLAND, CAL., FEB. 23d, 1891.

The facts and conclusions arrived at in these notes relate exclusively to the stored-water supplies at and near San Francisco, Cal.

The water sheds are all practically free from contamination with sewage or other foul drainage.

The conditions stated herein are those which generally arise each summer, more or less, and continue throughout the summer months until the winter rains set in.

TASTES AND ODORS IN IMPOUNDED WATERS.

Offensive odors begin to develop in reservoirs about the same time that putrefactive fermentation sets in, say, toward mid-summer each year. The first odor noticed may be characterized as "fishy."

The water also has a fishy taste and in addition leaves an after taste which might be likened to rancid oil. The waters in the reservoirs at this time of the season are full of algae together with myraids of water fleas. On closer examination it is found to be also contaminated with a whitish flocculent sediment. Investigation shows that this suspended matter consists chiefly of fragmentary remains of decomposed water-fleas.

It should be mentioned, however, that the cloth screening apparatus located at the inlet to the supply main, was found to be coated over with a mucilagenous slime which also had a fishy taste and odor. The exact nature of the slime has not been determined as yet. It is in every respect similar to the slimy coating which covers the outside surface of a freshly caught fish. It is possible this may play an important part in the taste and odor problem. As the summer season advances this fishy odor continues to increase in intensity until it becomes somewhat modified by the addition of hydrogen sulphide which eventually overwhelms it completely.

The next stage noticed is when the algae begin to die in large quantities and the waters become largely contaminated with dead and rotting vegetable organisms. The odors during this stage are very offensive, and are so extremely complex as to make it impracticable to give a clear and satisfactory description.

Much discussion has arisen as to the true cause of the hydrogen sulphide gas in the water. It has been clearly proven, I think, that it is due almost entirely to putrefactive fermentation going on in the deposit of oozy organic mud which covers the bottom of the reservoirs. It may interest members to know that during the worst stages of the evil the writer's silver watch was found to be much tarnished while he was engaged in taking observations on the lakes. I thought at the time that I had discovered something new, but further inquiry developed the fact that the tarnishing of silverware was a common mid-summer phenomenon in Mexico. Passengers travelling between Manqauilla and Colima had to take passage in small boats through a chain of dead water lagoons. On reaching their destination the passengers all noticed that their silverware had turned quite black. It is needless to say that it is a very unhealthy locality.

Let us now return to the subject of our own reservoirs. The bad conditions of the water continue until the winter rains set in when the cold muddy storm waters begin to flow into the reservoirs and gradually refill them.

As this process of refilling advances the offensive tastes and odors all rapidly disappear and do not return again until the following spring. At the beginning of this stage there is one feature I would call your attention to especially, namely, the peculiar manner in which the entire crop of algae is suddenly and completely annihilated by the first rush of muddy storm waters. The effect when first seen is quite wonderful, having one day a beautiful lake of pea-green water and perhaps the next morning instead you will observe the same lake filled with slightly muddy water and no signs of algae anywhere. Samples of water taken and examined

failed to show any traces of algae. As far as I have looked into the matter I am inclined to think that this effect is purely mechanical. That is to say the alluvial sediment brought down by the storm waters begins to settle as soon it reaches the ponded water in the reservoir and during the process of settling the sediment becomes entangled with the algae, in some way, and thus carries them down to the bottom, never to return. You might say that the algae are *buried alive* by the subsidence of the sediment in suspension. This is the only way I can explain the suddenness of the phenomenon. I think it highly probable that this natural feature may yet be put to some practical use.

It would be interesting to know if other members have had opportunities of observing similar effects elsewhere.

TASTES AND ODORS IN WATERS DELIVERED TO CONSUMERS.

In the spring of the year the first disagreeable feature noticed by consumers is an abominable fishy odor, which makes its appearance at the hot-water faucet. This generally begins to develop about the middle of May each year. This odor continues to increase in intensity until about the first of July when the cold-water faucets begin to deliver fishy-water. After drinking a glass of this water a peculiarly repulsive taste is left in the mouth and is suggestive of rancid oil. I have some good reasons to think that this spoiled oil is in some way associated with the water fleas. If a quantity of dead water fleas are collected and dried in the sun and then pressed between blotting paper, a very strong fishy oil is obtained which has an extremely persistent odor.

The fishy taste and odor experienced by consumers is undoubtedly intimately associated with the suspended matter contained in the water, which examinations has proved to be the decomposing remains of dead water fleas. The water drawn from the facucets contains them in prodigious quantities and in all stages of decomposition.

My reasons for thinking so are based partly upon the following simple experiments : A sample of water was taken from the cold water faucet and passed through a paper filter. The resultant filtrate, still having a fishy taste and odor, was put in a bottle and well shaken from time to time. The odor grew less and less, and finally in the course of twenty-four hours vanished entirely, never to return again. This would seem to indicate that the source of the taste and odor was suspended matter and not in dissolved organic matters. The suspended matter left in the filter was then examined. The water-fleas were quite dry and under direct sunlight had turned pink in color like boiled shrimp—indeed the odor evolved was likewise identical. Further examination developed the fact that nearly all the white flocculent sediment caught by the filter had also turned pinkish in color. A closer examination with a microscope plainly demonstrated the fact that the majority of the flocculent sediment was nothing more than the fragmentary remains of decomposed water-fleas. Moreover, a glass of water drawn from the faucets would always show them in all stages of dissolution. Furthermore, the filtrate, after remaining odorless for some time, was readily made to retake its former fishy taste and odor by simply re-adding the suspended matter removed by the filter.

The next phase in the quality of water delivered to consumers take place later on in the season when the decomposition of animal and vege-

table matter becomes much more active and putrifaction begins to show itself in the abundant development of free gases in the pipe system. During this state of the troubles, the taste and odors become so complex as to baffle any attempt to describe them, the predominent ordor being impure hydrogen sulphide.

This state of affairs continues until the winter rains set in, and the storage reservoirs become replenished with fresh storm waters. When this relief has fairly started in, then all the tastes and odors begin to disappear rapidly and do not return again until the following spring.

CONCLUSIONS.

As far as observations have extended there is as yet no reliable evidence tending to show that the most disagreeable tastes and ordors experienced in this locality, are in any way intimately associated with the Algæ existing in our storage reservoirs. The green spores of algæ in reservoirs certainly do pass through the cloth-screening apparatus at the inlet, and thus enter the pipe-system where they die and decompose in this manner, no doubt injuring the quality of the water delivered to consumers; but I have not yet been able to trace any relation between the worst tastes and odors and vegetable matters, which as a rule decompose very slowly as compared with animal matter.

This view of the question is furthermore fortified by the fact that a freshly taken sample of water always shows a large percentage of free ammonia. This universal fact justifies us in asserting that animal matter is most likely the true source of the ammonia.

Finally, I venture to say, I think that too much stress has heretofore been laid upon the general opinion that the origin of odors is to be sought in vegetable and peaty matters. They do exist, unquestionably, and in some cases may be predominant: but I am of opinion that they are, as a rule, subordinate both in their intensity and influence.

APPENDIX "B."

NEW ORLEANS, Dec. 4, 1890.

Prof. Albert R. Leeds, Hoboken, N. J.,

DEAR SIR: Our reservoir has a nominal capacity of 5,000,000 gallons. It is divided into four basins. It is uncovered. Until about a year ago this reservoir was used for supplying the city at night—which, as you will understand, involved the system of intermitent pumping. We pumped direct, by way of stand pipe by day, and supplied by gravity at night. The reservoir was thus in practical daily use until about a year ago we began the system of continual pumping, day and night. The reservoir was thus thrown out of active use and the water therein has been used only to prime the pumping engines.

Quite recently my attention was drawn to a grassy growth on the bottom of the reservoir. By reason of long standing and absence of agitation the ordinarily muddy water of the river had become quite clear in the basins, and the growth of which I speak had attained a height of five feet or more. The growth was in a number of nearly perfect circles of some six feet in diameter and covering the whole floor of the basin. At

or near the top of this growth were a large number of minute inhabited shells, and the play of an unusual number of minnows and small fish in and about the grass was noticeable. I drew the water off from the basins, allowing it to return to the river whence it came, and cleared the basin of the deposit. I found only some six inches of mud or salt on the bottom. The grass waved tall and green in the water but lay of course limp and lifeless upon the withdrawal of the water. Notwithstanding the freshness of the water the grass had a strong marine—(not to say fishy) smell, the cause whereof I cannot conceive. I send you a sample of it by this mail. Now these basins have been in use for thirty years or more, and no such growth or vegetable appearance of any sort has ever been observed in them before. I argue from the surrounding circumstances that aeration and agitation of water in reservoirs is unfriendly to vegetable growth. While these basins were in active use, no sign of it ever appeared. With their practical abandonment or disuse, it has appeared in great profusion.

This is written simply as a matter of a little interest and with the thought that possibly it may be of use.

Yours very truly,

L. H. Gardiner.

APPENDIX "C."

Spring Valley Water Works,
516 Calfornia Street,
San Francisco, Cal., Aug. 21, 1890.

J. M. Diven, Sec'y Am. Water Works Ass'n,

Dear Sir: Your communication dated July 1st inviting correspondence with superintendents and engineers of all water supplies, regarding the growth of vegetable and animal organisms, and offensive tastes and odors affecting water supplies, received.

The first water works of this city was started about the year 1859 and was a private company called the "San Francisco City Water Works." I started to work for it September, 1860, and Mr. C. W. Boynton was their engineer. They had great trouble with the water which came from Lobos Creek, a stream which receives its waters filtered from the surrounding sand-banks west of this city. The water in this creek is as clear as crystal and almost as pure as distilled water, and after running through a wooden flume, and cement pipe line (some four miles in length) it is pumped into reservoirs, one of which is 400′ x 300′ and the other 275′ x 275′ square.

These reservoirs had division walls in them, and for the first year and a half they had to be kept cleaned, first on one side and then the other, every ten days. In eleven or twelve days the green growth, known as frog-spittle, would clog up the No. 16 brass-wire screens as fast as they could be changed, and the water would get so bad in the pipes that all of the dead ends would have to be blown off twice a week. This continued during the whole year although our temperature is between 60° and 65° throughout the year.

I wil endeavor to make this communication as brief as possible.

We constructed a roof over these reservoirs of light posts and rafters and ⅞″ x 6″ tongued and grooved redwood lumber, sun proof. We examined the water from time to time for twenty years and during this time we have had no occasion to clean these reservoirs.

During this time the posts rotted and part of the roof fell in and while we were rebuilding it all fell in. We replaced it with a new roof and while building it we were obliged to clean it out every ten days as before. This second roof has now been on for more than ten years and the water is as clean and as clear as crystal and nearly as pure as distilled. We have got two boilers that were supplied with water from this reservoir for 28 years, and are quite good boilers yet.

Our next experience was with water in a lake about 20 feet in depth. We were troubled with heavy growths of tule and water grass, (grass that grows 15 and 20 feet long from the bottom.) We cut the tule out near the roofs with sickles on long poles and have completely killed them, and to get the grass out of the lake we used a long chain of ¼″ iron links which we fastened one end of to the shore, and then took the other end out in a boat giving it a long sweep (chain 800 feet long) then hitched two mules to the end and drew it ashore dragging all the grass out by the roots, but this did not make the water any better, as it took 12 men constantly shifting screens (covered with No. 16 brass wire cloth, six deep and 20 in a row, covered with cotton cloth) in order to keep the water anything like good. We had also to have all the dead ends blown off once or twice a week all over the section this water supplied. I could not build a roof as there was no foundation so I conceived the idea of building a raft and drawing from the center of it. This raft (400 sq. feet) is not quite as large as I would wish it, but since it has been built it takes only four men to shift the screens, two days and two nights and no longer any necessity for blowing off dead ends, and no complaints of bad water.

Since then we have covered another reservoir (from which water is pumped) 200′ x 150′, receiving its supply from Alameda creek, across the bay.

The grass had commenced to grow in it and clog up all the screens. We put on a roof to keep the sun off and in three or four days the grass all died, floated to the surface and was hauled ashore and carted off.

I think this is the best, least expensive and only sure way of keeping water good in reservoirs that are shallow, without wind and in hot climates. There is no vegetation in the shade in water, consequently, there can not be any decayed vegetation, and the fish will shelter under the raft and congregate in such numbers that they will eat up all the animalcula before it reaches the outlet, that is if you have the fish, which every well regulated lake and reservoir should have.

In water works business it is pretty hard to make superintendents agree, but if this is tried in any of the eastern water works I would like to have the credit of the suggestions made in this communication, and would like to make it as a separate communication from your committee.

With great respect to the committee and to you,

I remain yours, etc.,

Charles Elliot,
City Supt. S. V. W. Works.

APPENDIX " D."

OFFICE OF THE WATER COMMISSIONERS,
SPRINGFIELD, MASS., Sept. 17, 1890.

Sec'y A. W. W. Ass'n, Elmira, N. Y.,

DEAR SIR: In reply to the resolve of the American Water Works Association regarding the growth of vegetable and animal organisms, and the offensive tastes and odors frequently affecting water supplies, I beg leave to give the following data regarding the Springfield water supply.

The Ludlow reservoir was constructed in the year 1874; when full of water it covers an area of 445 acres, its contour line being a trifle over (7) seven miles, giving a storage capacity of (2,000,000,000) two billion gallons. The basin in which it is built, was composed largely of farming lands, a part of which was in a good state of cultivation as pasturage, grass, and tillage land; some 280 acres, part of which was swamp bottom, were covered with wood and timber. All this wood was cut close to the ground, and what was not removed was burned. A small portion of the most objectionable swamp land was covered with sand to a depth of about one and one-half feet. The stumps were not removed, but burned as much as possible while burning over the ground; large quantities of kerosene oil being used to ignite them.

The basin was considered to be, as a whole, admirably adapted for a storage reservoir, and will compare favorably with others throughout the county; but for all this the water has been *bad*, from the commencement to the present time.

The first few years, a scum—blue, green, and straw color, would form on the surface, from one to four inches thick, and about the consistency of soft soap. This scum usually appeared about the middle of June, and continued in a greater or less degree until the middle of September. For the last four or five years this heavy scum has not appeared, but there has been the same heavy growth of algae, resembling fine meal, giving the water a muddy green tinge, with the same disagreeable odor as when the scum formed on the surface.

The water has invariably been fairly good during the winter months, but as warm weather approaches, the vegetable matter begins to grow and soon the water has a very bad odor.

During no two seasons has the condition been just the same; the improvement has been so marked at times that we were encouraged to hope for a disappearance of the trouble, but the water has been as bad during May, June and July of this year as ever before.

The Ludlow reservoir has a drainage area of 10.82 square miles. On the easterly side, water is brought into the reservoir by the Broad Brook canal about 12,000 feet long; until November, 1886, this canal brought water from the Belchertown reservoir, a shallow body of water covering about 25 or 30 acres, also flooding, to a small depth, a large area of swampy land along Broad Brook, above the reservoir.

As it was thought that the water from this reservoir and the swampy land above, had an injurious effect upon that in Ludlow reservoir, the canal was altered and extended so as to intercept only the northwesterly branch of Broad Brook, which has a drainage area of about 2.3 square miles, the water in Belchertown reservoir being allowed to run to waste.

The Massachusetts State Board of Health have been wrestling with

the question of our water supply, for several years. In a report to the Water Commissioners of Springfield, dated September, 1889, they give the probable cause of the trouble in summer, as "the presence in Ludlow reservoir, of an enormous growth of blue-green algae, and a considerable growth of green algae." In the winter of 1888 the probable cause of the trouble was said to be "the presence of animal organisms 'Dinobryon.'" They gave us no encouragement to expect an improvement from natural causes.

I agree with the resolve, that this topic lies within the scope and objects of the American Water Works Association, and I trust the question may have a searching and thorough investigation, and result in finding not only a cause but a remedy.

The trouble with our water supply has been so persistent and unpleasant that the people have willingly appropriated money for a new supply, work on which is now going on with a fair prospect of its completion in the early spring of 1891. We do not purpose throwing away our old supply, but entertain the hope that science and experiment working in combination with practical common sense, will in the near future find some remedy for this trouble.

We are therefore, much interested in this question, and shall willingly do anything in our power to help the good work along.

I mail you under separate cover, our annual report for 1888, which contains analysis of the Springfield water.

Very truly yours,
J. C. Hancock, Superintendent.

Mr. Gardner: My nominal connection with the committee of which Dr. Leeds is the chairman, enables me to assure the Association that the continuance of the committee is of the utmost importance, and directly in the line of work for which this Association exists. I will ask to be dropped from the committee and that some member of scientific attainments be appointed in my stead. Meantime I beg to urge that the Association extend to this committee necessary financial aid to the extent of its ability.

I now move that the matter be referred to the Executive Committee for consideration and report.

The motion was seconded, and passed unanimously.

The President: I hope, gentlemen, the adoption of that motion will not affect the discussion of the subject. We want to have many such papers brought before us.

Mr. Woodruff: I would like to inquire whether Prof. Leeds has ever come in contact with a water supply or a pond in such a condition that the vegetable growth therein had developed so much decayed matter as to cause the water to ferment. This has occurred in

the city from which I come, where the pond from which water is received has a very strong moss growth at the bottom, several acres of which grow to a height of five or six feet and come up to the top of the water. When it decays that moss throws off a large amount of decayed vegetable matter, which seems to ferment in the water. Is this what you call a "growth of algæ?"

PROF. LEEDS: Mr. Woodruff has probably suggested the answer to his own question. The roots of the moss gradually decay, and in the process give off a considerable amount of vegetable matter, and connected with this is the development of the forms of algæ, from which the odors emanate.

G. H. BENZENBERG: A voluminous paper on the subject by Dr. Currier has recently been read before the American Society of Civil Engineers, and has elicited a discussion which brought forth some new facts. I believe that co-operative action with that society will be followed by like co-operation on the part of the National Board of Health, which has also had the subject under consideration at recent meetings. The mechanical features of water works construction are pretty well understood, but the quality and purification of water is a question which has not been investigated in a way to meet the demands of the near future, one which is bothering more or less all the larger water works corporations, whether municipal or private, throughout the country.

Referring to the question of bacteria as one of vital importance and upon which more light is desired, I think that Chicago is vitally interested in this, in view of the danger to its water supply and the difficulties that city may have to meet in purifying its supply. Nothing that the Association can do will prove so advantageous to it in acquiring and disseminating the desired information as the continuance of the committee with a liberal appropriation to facilitate all possible investigation by it. I feel satisfied that in the hands of Prof. Leeds a most thorough investigation will be made, with periodical thorough reports as the committee proceeds.

MR. DECKER: Mr. President—During last summer I had an experience with algæ that may be of slight inter-

est. In one of the works under my charge we pump from the river to a reservoir. The reservoir, which is of about 5,000,000 gallons capacity, is lined with brick laid in cement, and the surface cemented quite smooth. This lining is quite new, having been in use less than two years. Last May or June the river was quite low and the water, while not *perfectly* clear, yet was what might be termed commercially clear; that is, it carried no visibly suspended matter. There commenced a rapid growth of algæ, having the appearance of long blades of grass in bunches. The bunches were about the size of a bushel basket or somewhat larger, and contained quantities of small shell fish or snails. The propagation of this growth continued for about ten days or two weeks, when it began to die. The death and putrefaction of it caused a most disagreeable and offensive taste and odor to be imparted to the water, so much so that our consumers made great objections to its use. Even boiling would not remove it. This odor and taste was both of a cucumber and rotten wood order. We only rid the reservoir of the trouble by emptying it and thoroughly scrubbing sides and bottom.

A member here suggested that among the visitors were several members of the New England Water Works Association, and suggested that they be invited to enter into discussion with the Convention.

The President: I suppose they will not hesitate to speak for themselves. If any special invitation is needed to bring these gentlemen to their feet, they have it.

Would it not be worth while to ask the co-operation of the New England Society in this matter?

Mr. Coggeshall: I have no doubt but that the New England Water Works Association will heartily co-operate with this society in the work, for it is one in which we are equally interested, and I shall do what I can to bring the matter about.

Mr. Hawes: I am a member of the New England Water Works Association and have great interest in the work of both that and this Association. The subject of the purification of water has been before us for the past four years nearly all the time, and has been hashed and

rehashed. We know all about the bad effect of algæ in a water supply, and we have trouble before us on some of the rivers of New England. We used to be told that water purified itself by running down the stream for a few miles. This is hardly true. The city of Lowell takes water from the Merrimac river, into which the sewerage of Nashua and Keene, a few miles above, has been discharged. Then Lowell empties its sewerage into the same river from its 80,000 people, and only nine miles below Lawrence takes its supply. They have had an epidemic of typhoid fever in these cities, and finally the water became so bad that they were compelled to boil it, which only brought up the question of whether they would rather have the impurities boiled or raw. I hear of a process by which pure ice can be extracted from the salt water of the ocean. I do not know enough about it to explain it, but the salt and all impurities are extracted from the water by certain processes, and it is then frozen into ice purer than that from any spring water that comes from the earth. We that live on the coast have the whole Atlantic ocean at our command, and all we have to do is to turn the ocean water into pure ice by the process suggested and then cart this ice up to our reservoirs, put it in and let it melt. Thus we can supply the whole world with ice water. So we do not need to worry any more on the subject. One idea I would like to impress, is that you shall recommend something for a drink while considering this matter of purification. At Fall River we have very pure water, no moss or fish growth or anything of the kind.

Mr. Gardner offered the following resolution :

Resolved, That the President appoint a committee of three, of which Prof. A. R. Leeds shall be chairman, in continuance of the present committee on Vegetable and Animal growths affecting water supplies.

This committee, so appointed, shall be empowered to confer with the National Board of Health, the American Society of Civil Engineers and the New England Water Works Association, with a view to co-operation in the line of the proposed study and investigation.

On motion the resolution, having been seconded, was passed unanimously.

Mr. Devonshire: In 1884, when I was in charge of the water works at Antwerp, Belgium, we had consider-

able trouble on account of the bad taste of the water, and it was found eventually that this was due to the growth of spongilla in certain pipes. The intake pipe between the river and the storage reservoirs was always partially submerged, the part under water being covered with the spongilla growth while the part of it exposed to the air was entirely free from this. The 24-inch pipe, some 300 feet long, running from the storage reservoir to the pumps, was found, after a long search, to be almost closed up with weed growth which gave off a very offensive odor and taste. The weed grew in such quantities that the force of the water through the pipe finally detached portions of it, and these portions were carried upon the surface of the sand filters, where it again started to grow. The spores from this growth passed through the sand filters with the water and caused a green mossy growth on the walls of an underground pure water tank which was lined with cement.

THE PRESIDENT: The convention is very fortunate in having the expressions of opinion from men so widely separated. It was hardly to be expected that we would hear from Europeans.

The next paper upon the programme is Riveted Steel Water Pipes, by D. J. Russell Duncan. I have a printed copy of Mr. Duncan's paper, which as you say embraces a small volume of some fifty or sixty pages and I regret to say that the printed copies are yet in the Custom House and are not yet released. The matter is being attended to and we shall be able I hope to supply all of you.

A motion was made and seconded to insert the paper on Steel Pipes in the minutes—passed unanimously.

RIVETED STEEL PIPES.

BY D. J. RUSSELL DUNCAN, ASSOC. M. INST. C. E., M. INST. M. E.

The application of steel in the construction of water pipes is of comparatively recent date in Great Britain, and has developed a new and important industry, which seriously enters into competition with the old-established methods of pipe-founding. In all branches of industry employing iron there have been three periods during which, by progressive stages, cast-iron, wrought iron, and steel have been used, and new systems of construction have gradually developed as improvements in

the production and in the quality of material have been effected. Modern designs for the construction of bridges and roofs afford notable instances of the changes which have occurred, not only in the description of metal used, but in the wider range of operations which the introduction of the refined material—steel—has opened up.

It is unnecessary to enumerate in detail instances of remarkable engineering structures which would have been scarcely possible in cast-iron, but which have been successfully accomplished by the aid of steel. Members of American and British Commercial and Industrial Associations are sufficiently familiar with the scientific progress in metallurgy which has permitted the erection of the Eiffel Tower, the Fort Bridge, and the enormous extensions of the railway systems throughout the world; but the new industry of steel pipe manufacture is not so well known.

The old custom of employing cast-iron prevails to a great extent in Great Britain; while America has for many years built pipes of wrought-iron, and is only now making occasional use of steel. British progress has developed from cast-iron to steel without passing through a long period of wrought iron. The explanation is simple. America at one time required to purchase from Great Britain, and soon found that wrought-iron plates brought from England when built into water mains cost less than imported cast-iron pipes, the bulk and weight of the latter involving very heavy charges for freight. On the other hand, cast-iron pipes maintained their supremacy in Great Britain because of the plentiful supply of metal, the simplicity of construction, and the accessibility of the foundries to the pipe tracks.

As each country naturally preferred the cheapest article, the habit of specifying wrought-iron pipes in America and cast-iron pipes in Britain became general.

The introduction several years ago, of mild steel brought about a great change in the British iron trades, resulting in the erection of several large works for its production. At these works machinery was erected capable of rolling plates of larger area than had hitherto been customary at other works manufacturing wrought-iron—the facilities offered by larger plates of steel for general purposes rapidly secured the successful development of the new industry, and permitted the construction of steel water pipes at prices which brought them into competition with cast-iron pipes.

America being early in the field as a manufacturer of wrought-iron pipe from plates—chiefly imported from England—equipped her works with plant and machinery suitable for the sizes of plates then procurable; Britain entering upon the plate pipe industry at a much later date has installations of machinery adapted to the dimensions of the steel plates as now rolled. Hence it has become the practice in America for engineers to specify wrought-iron pipes built from a large number of small plates, and for British engineers to employ a small number of large plates. The advantage of the latter course is obvious, as the number of seams, whether welded or riveted, is greatly reduced.

The number of seams and cost of making them had proved to be great obstacles, which hindered the adoption of wrought iron pipes in Britain, even had the prejudices against the use of wrought iron in regard to the strength and durability not existed.

Water engineers were, before the days of steel, in many cases ignorant of the strength of wrought-iron, and could not realize that a thin plate pipe of comparatively pure metal could be as strong and as durable as a thick pipe of cast iron—an impure metal. Therefore, with prejudice and cost against the adoption of wrought-iron pipes in Britain, the old custom of using cast-iron still prevailed; but in America financial considerations over-ruled prejudices, and the cheaper form of pipe (wrought-iron) was adopted.

The example shown by America in the extensive use of wrought-iron pipes induced the writer, some ten years ago, to investigate the cause of the difference between American and British practice, and believing that if pipes made of wrought-iron or steel could be produced in Britain at a less cost per unit of length than cast-iron pipes, the prejudice against such pipes could be argued and overcome, careful study was given the subject, and plans matured for producing plate pipes of larger diameter with less riveting than usual in American practice. As this could only be affected by the strictest economy in weight of materials and labor, it became a necessity to employ metal of the highest possible tensile strength; or in other words of the greatest strength and minimum thickness, and this could only be accomplished by the use of Siemens-Martin mild steel, as then made by the Steel Company of Scotland, Limited, Glasgow.

To make this more intelligible. At a time when only plates of wrought-iron were obtainable, a pipe, say 34 inches external diameter, ¼ inch thick, would be built of two plates in the circumference, such plates being not more than 42 inches wide. At the present time if built of steel of the same thickness, there would be only one plate in the circumference, and it would be 63 inches wide. Assuming that the laps in the seams are respectively 2¼ inches longitudinal and 1¼ circumferential, and the rivets are 1½ inch pitch in the double riveted longitudinal seam and 1½ inch in the single riveted circumferential seam, and the riveting is the same in both wrought iron and steel pipes—it is clear that in a length of 1000 feet there would be required:—

	Wrought Iron.	Steel.
No. of plates, . . .	588	194
Size each plate, . .	59″ x 42″	115¾″ x 63″
Total weight of plate, . .	27.79 tons	28.03 tons
Number of rivets, . .	57,036	32,980
Total weight of rivets, . .	0.69 tons	0.40 tons

It is manifest that steel posesses decided advantages in economy of labour, as the reduction in the number of plates and rivets implies proportionate reduction in caulking and punching.

The question of durability is one which is frequently referred to, and about which many opinions are expressed. In 1886, the writer's firm being desirous of obtaining the scientific evidence of expert analysts, obtained reports upon specimens of cast-iron, wrought-iron and steel. These reports were published in 1887, and show that steel is less liable to corrosion than wrought or cast-iron.

The best precaution against corrosion is to have the pipes galvanized, then coated with natural asphaltum, or when the latter is not procurable with a a specially-prepared composition of pitch, tar, petroleum, linseed oil and chalk. The composition is melted in a horizontal bath, heated to a temperature of 250 degrees. The pipes are immersed, and remain

in the bath until they acquire the same temperature as the fluid composition. As the pipes are lifted out, it is desirable to rotate them on the surface of the composition; the thickness of the coating can then be increased to $\frac{1}{32}$ in., or greater if desired. The smooth glassy surface thus produced quickly sets hard, and when the pipes are laid in the ground no injurious action results from contact with damp earth.

Pipes should, if possible, be coated as they are laid in the trench, even although they have been coated at the manufacturer's works. The advantage of this is apparent. All surfaces abraided in transit are recoated and preserved.

Galvanized pipes should not be laid in the earth until they have been coated, as in many instances acids in the earth decompose the zinc, and corrosion sets in more rapidly in such cases than would be possible in pipes not galvanized.

With regard to tensile strength as compared with other material used for pipe manufacture, steel is undoubtedly the very best material. The ultimate tensile strength of glazed stoneware pipes never exceeds 350 lbs. per square inch; flint glass, 2,400 lbs.; cast iron, 18,000 lbs., steel, 62,720 lbs. The relative strengths are therefore—

Glazed stoneware	1.
Flint glass	6.587
Cast-iron	51.4
Mild steel	179.2

Steel is 179.2 times stronger than earthenware, and 3.48 times stronger than cast-iron.

Specifications for wrought-iron pipes usually limit the tensile strength of plates between 50,000 lbs. and 60,000 lbs. per square inch. The practice for steel plates ranges from 56,000 to 72,000 lbs. For comparison a fair approximation is arrived at if wrought-iron is taken at 50,000 lbs. and steel at 65,000 lbs. As steel is therefore on an average 1.3 times stronger than wrought-iron, it is clear that for pipes of equal strength of plate, and allowing that the riveted or welded seams are also of equal strength in both, the thickness of mild steel need only be about .77 of the thickness of wrought-iron.

Leaving factors of safety and the strength of seams out of consideration for the present, the bursting pressure of a pipe is expressed by the formula—

$$p = \frac{t \times 2s}{D}$$

Therefore, assuming an ideal pipe, in which the tensile strength of the plate is uniformly maintained throughout, and that the plates are 0.2 in. thick, and the internal diameter is 20 inches, if made of wrought-iron of 23 tons or 51,520 lbs. tensile strength, p. the bursting pressure would be 1,030 lbs.; but if made of steel, of 30 tons or 67,200 lbs. tensile strength, p. would be 1,344 lbs., or 1.3 times greater than for wrought-iron

In like manner, if an ideal pipe of wrought-iron is compared with one of equal strength of steel the formula becomes—

$$t = \frac{P \times D}{2s}$$

Therefore, a wrought-iron pipe 20 inches internal diameter, having a resistance to bursting of 1000 lbs., would require to be made of plates 0.1941 in. thick, and a steel pipe of plates 0.1488 in. thick, the thickness of steel being 0.7667 of wrought-iron.

Allowance must be made for loss of strength in riveted seams, unequal strength of plates and a sufficient margin of safety be provided to meet variations in pressure, friction, wear, collapse, and other causes of weakness.

The custom in America has been to work more nearly to the bursting limits than in Great Britian. Some manufacturers in America calculate the working strength of pipes on a low basis of 7,500 lbs. per square inch of section of plate, but in many cases the working strength is based upon wrought-iron having safe limit, after all deductions for loss of strength in riveted seams, of 12,500 lbs., and others go as high as 18,750 lbs. In other words, if wrought-iron, as used in America, has a tensile strength of 50,000 lbs. per square inch of section, and 25 per cent. is allowed for reduction in strength at riveted seams, the factors of safety range from 5 to 2.

One of the most recent steel pipe lines of considerable importance, constructed upon American principles of design, is that for the Vancouver Water Works, fully described by Mr. H. B. Smith, M. Can. Soc. C. E., in his paper to the Canadian Society of Civil Engineers. In his reply to the criticisms made upon his paper, Mr. Smith says the tensile strength of the material is 72,000 lbs., 75 per cent. of which is treated as the net strength of the riveted seam; thickness of plate, 0.11 in.; factors of safety ranging from 7.6 to 4.13, and he gives also a table showing that riveted wrought-iron pipes used at Virginia City, Nevada, have factors of safety ranging from 5 to 2.40.

Taking these instances as evidence of modern Canadian and American practice, the average factors of safety are 5.865 in Canada, and 3.6 in the United States. In the former case steel has a tensile strength of 72,000 lbs., and in the latter wrought-iron has 55,000; the average net strength of each material per square inch of section is 9,000 lbs. for steel and 10,700 lbs. for wrought-iron.

The most recent British practice is to allow 60,000 lbs. for ultimate tensile strength, and to consider the resistance to internal pressure under four classes—

(*a*) High pressure pipes, double riveted.
(*b*) Medium " " " "
(*c*) Low " " " "
(*d*) " " " single "

(*c*) and (*d*) are for pipes wherein the pressures are low, but the thickness must be increased to resist corrosion, external pressures, and to provide stability.

The following table gives the data upon which the strength of riveted pipes is based:—

	No. 1.	No. 2.	No. 3.	No. 4.
Ultimate tensile strength....	lbs. 60,000	60,000	60,000	60,000
Deduct for variation of thickness in rolling	2½%	2%	1½%	1%
Deduct for loss of strength in riveted seam.....	30%	44%	58%	72%

Total deduction.....	32½%	46%	59½%	73%
Factor of safety.....	5	5	5	5
Net strength of pipe per sectional square inch of plate.....	8,100	6,480	4,860	3,240

Bowie, in his "Practical Treatise on Hydraulic Mining," page 160, states that the Spring Valley Water Company strain their pipes from 11,400 to 13,000 lbs. per sectional inch, and in table XV in the same volume it is stated that a pipe at Texas Creek is strained to 16,952 lbs., and in table XXI reference is made to a pipe in the Cherokee line which bears a maximum strain of 17,540 lbs.

16,040 lbs is the working strength of plate in one case in pipes referred to by Mr. Smith in his table of strengths and pressures of riveted wrought-iron pipes in Virginia City, Nevada, working under heads up to 950 feet. Diameter, 11½ inches; thickness of plate, 0.148 inch; factor of safety, 2.40; ultimate strength of plate, 55,000 lbs.; reduction for loss of strength in riveted seam, 30 per cent.; and in another case in the same table for pipes working under heads up to 200 feet—diameter, 11½ in.; thickness of plate, .065; factor of safety, 5; ultimate strength of plate, 55,000 lbs.; reduction in strength of riveted seam, 30 per cent., the net working strength per sectional square inch of plate is only 7,700 lbs.

Cases have also been reported from America in which the factor of safety is only 1.5, but no authentic information can be obtained regarding the tensile strength and co-efficient for weakness in riveted seams; but, assuming the former to be 50,000 lbs., and the latter 30 per cent., the working strain upon plates would be as much as 23,333 lbs., which is certainly most dangerous practice.

An examination of the general principles affecting the working pressure, diameter of pipes, and thickness of plates, points to a very wide diversity of opinion amongst manufacturers: the range in America, from 18,750 to 7,500 lbs. for wrought iron, indicates that the subject of thickness in relation to diameter and pressure is either not considered at all, or that manufacturers run great risks in a reckless manner for the sake of commercial advantage. The extremes above quoted, if applied to the case of a pipe 20 inches diameter, working pressure 200 lbs. per square inch, indicates that the speculative maker would build his pipe of plates .107 inch thick, and the cautious builder, of plates .258 inch thick. The tendency in America appears to be to use lower factors of safety than are customary in Great Britain, and the absence of a recognized standard on which to base specifications permits of too great freedom, and gives latitude to speculative traders to undermine the principle of fair trade competition. There is no reason why manufacturers should not agree upon a standard scale of measures applicable to rivited steel and wrought-iron pipes. To arrive at consistency and uniformity a mean might be established which would at the same time be in accord with American practice in regard to low factors of safety, and yet conform to British ideas in dealing with steel. To secure this object the writer proposes the adoption of the four classes of riveting previously referred to, and that all calculations shall be based upon an ultimate strength of material of 60,000 lbs. This is higher than the average ultimate tensile strength of American wrought-iron, and considerably lower than that of the best qualities of British steel; but as a uniform factor of safety 5 is proposed,

the net strength is nearly equivalent to the general average in American specifications, and well within the limits of safety recognized in Britain.

An allowance is provided to overcome usual variations in thickness of rolled plates, calculations being based upon the minimum thickness of plates after deduction of steel manufacturers' margin.

From the very wide range indicated it is clear that no satisfactory rule for calculating strength of wrought-iron or steel pipe is in practice, and, as purchasers of pipes cannot always be expected to investigate the principles which govern manufacturers in recommending thicknesses and systems of riveting, it seems to the writer that a discussion on this important matter would not only be of advantage to the public, but also to manufacturers, and he, therefore recommends to the American Water Works Association that at their Convention in April the following resolution be submitted for adoption :—

That this Association, with a view to ensure public safety, economy in construction, uniformity in design, and consistency in the application of wrought-iron and mild steel riveted pipes for conveying steam, water, and gas, do hereby adopt and recommend for universal adoption the standards for strength and pressure, resulting from the formulæ :

$$t = \frac{p \times d}{16200} \qquad p = \frac{t \times 16200}{d} \qquad d = \frac{t \times 16200}{p}$$

t = thickness of plate in inches.
p = safe working pressure in lbs. per square inch.
d = internal diameter of pipe in inches.

16200	is the coefficient for	double-riveted	pipe system	(*a*)
12960	"	"	"	(*b*)
9720	"	"	"	(*c*)
6480	"	single-riveted	"	(*d*)

Questions regarding resistance to collapse from external pressure sometimes arise. It therefore becomes important when laying down plans for water supply to know the depths at which the pipes will be laid, otherwise large pipes, whether earthenware, cast-iron or steel, are liable, the two former to fracture, the latter to collapse by bending, wherever the depths of the pipes under road level is insufficient to prevent the weight of heavy wagons bearing upon them.

Whenever external pressure has to be considered, the best forms of steel pipes are those made up of short cylinders of welded pipes riveted together with butt joints and external cover strips, such strips occurring at intervals of 4 to 6 feet apart.

The frequency of these circular cover strips adds considerably to the strength of the pipes, as the strips act as stiffening beams in resisting external pressure.

Pipes laid at a depth of four diameters are not affected by surface loads, and the question of collapse need not in such cases be considered. This fact should be borne in mind.

Generally, it may be taken as certain that whenever a cast-iron pipe 1 inch thick is safe, a steel pipe $\frac{1}{4}$ inch thick is safer. In the one case the cast-iron will break and leak if undue loads are imposed, but in the other only flattening or bending without leakage occurs.

Calculations for resistance to collapse are entirely different from those for resistance to internal pressures. No reliable formulæ have yet been introduced for such calculations. The nearest approximation for general purposes is—Resistance to internal pressure = 1.0; resistance to external pressure = 0.4.

The methods of coupling pipes together are very numerous, the common form of screwed joints used for small tubes is not applicable because of the expense in large diameters, and is objectionable because of the waste of material.

The strength of a pipe to resist internal pressure must always be calculated at the thinnest and weakest part. If a pipe is screwed, as shown (Fig. I.), the metal is thinnest at the bottom of the thread, and the limiting thickness of pipe for working pressure required must be at that point on the dotted line A. The extra metal between the lines A and B throughout the whole line of pipes is no use, and adds weight and expense to the pipe. The thickness A C must be sufficient to stand the pressure, and the only means of economizing the material and yet maintaining the full strength of the pipe is by swelling the end of the pipe (Fig. II.), but this adds greatly to the expense, and cannot therefore be recommended for pipes over 6 inches in diameter.

The joint (Fig. III.) is used for small tubes, but is not recommended for large diameters.

The tubes are expanded at the ends, after having loose flanges B B fitted over them, and are drawn together by bolts and nuts over a turned core A. This joint is very cheap, and has the advantage that the joints may be quickly made, also that the tubes may be very thin, but it has the disadvantage of projecting loose flanges which are not convenient for shipment.

The Schulz Patent Joint (Fig. IV.) is a very good one for welded pipes, but it has the disadvantage that the thickness of the metal is reduced at A, the point of largest diameter, and therefore the point where greatest strength is required.

The Duncan Patent Joint (Fig. V.) is better than the last, because the socket can be rolled of steel of greater thickness than the pipe, thereby giving greater strength when wanted. The socket is shrunk upon or riveted to the pipe, and in some cases the pipes are expanded into the socket in the same manner and by the same process as the expansion of boiler tubes into tube plates.

A feature of this joint is the bearing surface of the spigot on the bottom of the socket. It is so designed that the surface of contact is spherical and allows the angular deviation, horizontal or vertical, up to the limiting point at which the spigot end of the pipe touches the extreme end or mouth of the socket.

The circle represents a sphere, and it will be seen that the bearing of the spigot upon the socket is upon its surface.

The best joint on the socket and spigot principle is a development of the two former, and is known as Riley's Patent Stamped Steel Socket Joint (Fig. VI.)

The great advantage of this joint is the stiffness obtained at the mouth of the socket by the rim, which is favorable for caulking with lead.

Stamped sockets are also truly cylindrical, and being without welded seams greater strength is obtained.

The Converse Patent Lock Joint (Fig. VII.) is an excellent form of joint, made of a cast-iron collar with lead space at both ends, the collar having recesses into which projecting rivet heads fixed on the ends of the pipes are inserted, and locked by moving the pipe through a small part of its circumference.

The form of joint known as the Kimberley Joint (Fig. VIII.) is similar to the Converse Patent Joint, excepting that the pipes are not locked into the joint.

The next form of joint to be recommended is the Flanged Joint (Figs. IX. and X.)

The flanges are preferably stamped in dies, in which case they are truly cylindrical and do not require to be faced, but they are sometimes made from angle iron welded into rings.

Numerous other forms of joints are necessary, according to circumstances. When drainage pipes of large diameter are required the simplest joint is a tight-fitting socket and spigot joint, drawn together by lugs and bolts (Figs. XI. and XII.)

The joint (Fig. XI.) was first used for the storm outfall 36 inch diameter at Bournemouth. The pipes were laid under sea water and jointed by divers.

As steel pipes are usually supplied in long lengths, welded pipes 14 ft. to 18 ft., and riveted pipes 18 ft. to 40 ft., it is necessary to provide means for allowing angular deviation in the line of pipes without creating strains in the joints. This is effected by making the ends bear upon each other at an angle of 45° (Fig. 5).

The Converse Lock Joint does not allow of much angular deviation, but the other forms referred to (excepting the Flange Joint) will nearly all allow considerable divergence from the true line, whether horizontal or vertical.

Special attention should be given to bevelling the spigot ends, because it saves a very great deal of time in laying pipes, and there is no risk of fracture or leakage: whereas when laying cast-iron pipes the greatest possible care must be taken to fit the pipes together in perfectly true lines, otherwise the strains set up in the joints by the leverage, due to the length of one or more pipes hanging upon the joint, frequently causes fracture at the joint.

The simplicity of all the joints referred to is an important feature in their favor. They can all be made by men ordinarily accustomed to laying cast-iron pipes, and are more easily handled, no complication of any kind, either regarding yarn packing, lead packing, levelling, caulking or finishing, ever being met with.

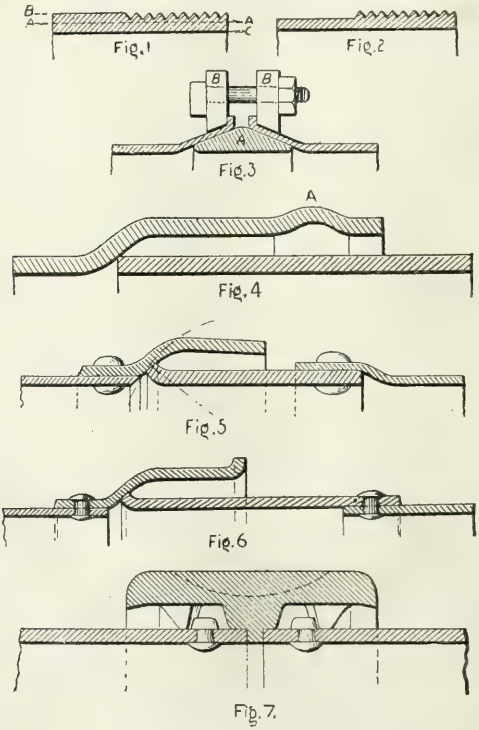
The saving in cost of lead, laying, time and labor by using these joints as compared with joints of cast-iron pipes must be noted. If riveted steel pipes are used in 24 ft. lengths, instead of cast-iron pipes in 12 ft. lengths, it is obvious that there are only half the number of joints to make, but each joint uses only about 75% of the lead required for a cast-iron pipe joint. The mean diameter of the annular space for lead is smaller than in cast-iron pipes, because the thickness of steel in the pipe is less than the thickness of metal in the cast-iron pipe.

Tightness of the joints is increased by the use of steel sockets, because the lead can be caulked more firmly than in a cast socket, as there is no danger of splitting. The risk of leakage is also reduced in consequence of the reduced number of joints.

The superiority of the coating used for steel pipes—its smooth and glassy surface increases the discharge of water through *welded* as compared with cast-iron pipes, because the friction is very greatly reduced ; but no advantage can be claimed for increased discharge through pipes which are riveted together with rivets whose heads project inside the pipe. The projecting heads obstruct the flow, even although carefully coated, and the advantage of smooth bore can only be claimed for welded pipes.

The method of riveting the circumferential seams together is illustrated in Fig. XIII. This system not only maintains uniformity in the internal diameter of the pipe, but greater accuracy in riveting. The plates are punched on multiple punching machines, bent into cylinders, and the ends required to overlap are expanded by suitable machinery.

In conclusion, the writer desires to emphasize the main point in this paper—viz., the suggestion that an international standard of thickness and pressure should be adopted, and to facilitate this object, tables of working pressures for steel and wrought-iron pipes, ranging from 3 inches to 48 inches diameter, are annexed, as well as tables* suggesting standard systems of riveting.



*Copies of tables referred to can be had by applying to J. M. Diven, Elmira, N. Y.

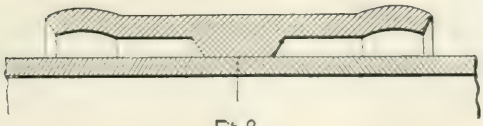


Fig. 8.

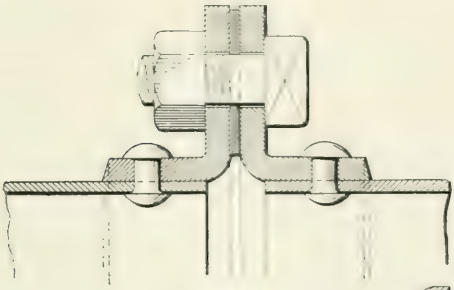


Fig. 9.

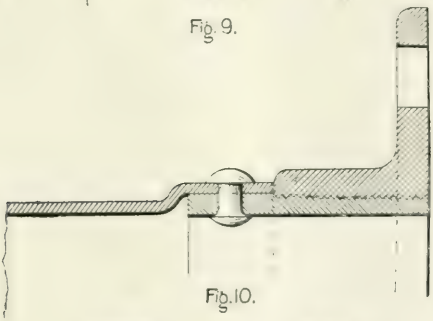


Fig. 10.

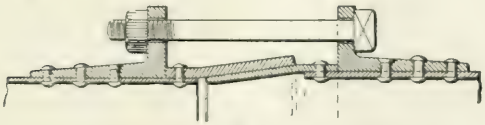


Fig. 11.

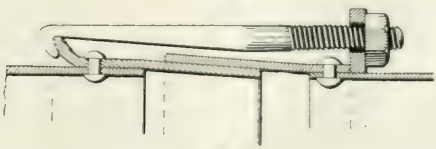


Fig. 12.

Fig. 13

THE PRESIDENT: The next paper is by Mr. McAlpine.

THE SECRETARY: Mr. McAlpine is not present, and I have not received a copy of his paper. I have a paper by Mr. Tubbs which I think we will have time for at this session.

THE PRESIDENT: If there is no objection the Secretary will read Mr. Tubbs' paper.

IS THE GENERAL APPLICATION AND USE OF WATER METERS ADVISABLE IN SUPPLYING POTABLE WATER TO CONSUMERS, AND WILL THE PRACTICE PROVE REMUNERATIVE TO THE OWNERS OF THE WORKS?

In a paper read before this Association on another occasion, the writer called your attention to the fact that schedules of water rates were usually established on the basis of rates charged for water in other cities and towns of similar situation and approximately like population, without much consideration, or reference to the differences which may exist in the location, quality of water or cost of the works. It therefore results that injustice frequently inures, to either the owner or consumer, and hence it is believed that we are warranted in the statement, that if any more accurate determination can be made of the equities as between the parties in interest, it should be so made.

The writer is of the opinion that the water meter furnishes the key to this determination, and for this and other reasons to be given, should be generally used for the purpose of measuring out water by water works managers to their consumers.

To enable him to concisely present his views upon this question, the writer suggests three distinct propositions, which he will treat as objections to what is commonly known as the "Schedule Rate" system of charges for water as distinguished from the "Meter System."

These three objections to the "Schedule Rate" System are as follows:

(1.) Its results are unsanitary.

(2.) It is unjust in its operation.

(3.) It is liable to result in financial loss to owner or consumer.

In relation to the first proposition, it may be stated, that twenty years ago it was the practice of hydraulic engineers in designing a new system of water works, to provide for a supply of sixty gallons per day, per capita of the estimated population at the end of fifteen to twenty years.

As the result of the habit of enormous waste which has grown up, and been fostered by the practically unrestricted "Schedule Rate" System, the practice of the hydraulic engineer of to-day is to provide a supply of at least one hundred gallons per day per capita, and many conservative men in the profession believe that a safe provision is not less than one hundred and fifty gallons per day, and this opinion is fairly

sustained by a collation of the data in relation to the amounts used in various cities in this country at the present moment. Within a few months, but for another purpose, the writer had occasion to collect from first hands the following statement of the quantity of water used per capita of population daily in the following named cities:

Toronto, Ontario—131 gallons.
Milwaukee, Wis.—110 "
Detroit, Mich.—148 "
Troy, N. Y.—170 "
Buffalo, N. Y.—170 "
Springfield, Mass.—91 "
Cleveland, Ohio—$98\frac{7}{10}$ "

It must be borne in mind, also, that each of these cities has considerably reduced its daily per capita consumption during the past few years by a moderate introduction of water meters applied to the services of large consumers, and still the results of the "Schedule Rate" System are sufficiently startling and alarming to invite the studious attention of thinking men, and the manifest waste fostered by the system will serve to illustrate the point I am about to make, that the result is distinctly unsanitary.

It is a further fact, well known to the members of this Association, that the sewage of all towns in this country having water works supplies is conveyed to some point outside the limits thereof by water carriage through the sewers. Any excess of water discharged into the sewers in addition to the amount required to convey the sewage beyond the town limits before putrefaction occurs, by so much increases the difficulty and expense of the sewage purification and disposal. As a consequence of the enormous dilution of the sewage, largely resulting from the immense waste from the several water supply systems, and the great cost attendant upon properly treating and purifying the same by modern methods of precipitation and filtration, it has become next to a universal practice to avoid this expense by emptying the raw sewage into the nearest stream or lake. As a result of this practice very few of the natural streams or lakes adjacent to our towns are at all fit to act as the natural sources of water supply for said towns, but are, on the contrary, a constant menace to the health of the people.

Could the dilution of the sewage be restrained within proper bounds the cost of the various received methods for the treatment and disposal of sewage might be reduced to such limits as to bring it within the means of almost any town, and the wholesale pollution of the neighboring streams, ponds and lakes would thus be abated.

Much might be suggested as to the effect upon the health of large communities by the general fouling of streams and ponds in this manner, as influenced by the use of milk and the flesh of domestic animals drinking from these impure sources, loaded with disease germs. Also of the malarial effects of a practically unrestricted use of water upon lawns and street roadways, but as this is not intended as a sanitary paper I leave the subject for your further mental elaboration.

A mere statement of my second proposition, that the "Schedule Rate" System is unjust in its operation, is perhaps sufficient to commend it to the experience of practical water works managers. All must admit that the relation is very remote between the amount of water used for

domestic purposes and the assessed valuation of the consumer's house and lot, or with the width of his house, or its height, or the number of rooms it contains, or the number of faucets attached therein. It is also a fact that the number of persons constituting a family is no accurate measure of the quantity of water used or wasted. Could a fair estimate of the conscientiousness and honesty of each of said occupant consumers be also made, then with this element known, a more equitable standard of fixed rates might be established than any of those to which I have alluded.

With the power of unrestricted waste practically lodged in the hands of the consumer, the water manager must make such large fixed rates for special uses as will not prove unjust and burdensome to the honest and conscientious user, or else the water works owner will suffer the injustice of having his property wasted by the unscrupulous consumer, while the sale by measure will protect both parties alike.

The further question as to whether the meter should be furnished by the water works owner or the consumer, has given rise to much debate, but from the standpoint of the writer the solution is very simple.

The fundamental idea in the inception of all water works schemes, whether constructed by a private company or a municipality, is that of gain or profit. In the case of a private company, it is entirely an idea of financial gain, while in that of a municipality there also obtains the further idea of subserving the public health and general comfort of its citizens; but in each case the basic idea is one of gain or profit in some form, as stated.

With this end in view, it is important that all of the appliances by which water is collected, stored, conducted to, furnished and measured to the consumer, should be durable of their kind and fully under the control of the party making the financial investment, for on the whole of the investment made the investor rightfully anticipates an adequate financial return. This return he expects for the money paid out by him for water rights, rights of way, for water pipe, for reservoirs, hydrants, gates, engines, boilers and the depreciation and management of each of these; and if so, what good reason can be presented why he should not also receive an equitable return for the cost, maintenance and depreciation of the meter by which the water is measured to the consumer in an equitable way.

In short, a meter should be placed on each and every service attached to the works, and these meters should be reckoned as a part of the cost of the water works plant, on which the owner is to receive his profit, and this cost and profit is to be included in the determination of the price charged for the measured water.

It has been suggested by some that the advocates of this plan might as well insist that the service pipes, faucets and other fixtures for the using of the water inside the premises should also be furnished by the water works owner. This, however, is not logical. When the water works manager has placed the meter inside the basement wall, he has provided the consumer with access to the water and an automatic measure of the quantity used, and it is no more a part of his province to determine for the consumer the architectural designs or luxuriousness of the plumbing arrangements for his baths, water closets and wash stands than it would to determine for him the general furnishing of his drawing rooms.

When the company or municipality has furnished all that is necessary to give access to the water and the proper measuring of the same, then it is a matter of no import whether the consumer shall elect to take all his water supply from the basement or whether he shall expend his thousands of dollars in the extension of his pipes and fixtures to all parts of his mansion and in their elaborate and æsthetic adornment.

My third proposition is "that the Schedule Rate System is liable to result in financial loss to owner or consumer."

The argument which leads to this conclusion can perhaps be best developed by the working out in detail of a purely hypothetical case.

As heretofore stated, experience has demonstrated the fact that the average daily use of water per capita of population from systems operated purely on the schedule rate plan is not less than 100 gallons, and that in those systems in which the whole or a very large percentage of the services are metered, the amount thus used does not exceed, on the average, 50 gallons.

It therefore follows that whatever the amount of the supply provided in the first instance, that supply will prove adequate for a period twice as long under the meter system as under the rate system, provided the yearly accretion to the population remains the same, and the saving would be largely determined by a comparison of the cost and maintenance of the required number of meters with the estimated cost of a duplication of the whole works.

Let us assume, then, the following hypothetical case as an illustration:

The present population of a town is	5,000
" estimated population at end of 20 years	10,000
" yearly increase of population	250
" total capacity of the works per day in gallons	1,000,000
" daily use per capita, in gallons, when operated under a "Schedule Rate" plan	100
" daily use per capita under the Meter plan	50
" estimated number of users to each service	5
" original cost of works	$100,000
" average cost of each meter, with setting	$18
" average yearly cost of repairs for each meter	$0.32
" yearly interest on each meter and cost of setting	$0.90
" average life of each meter in years	12
" yearly rate at which interest is compounded	5 %
" number of services attached and meters used each year	100

On the basis assumed in the foregoing, at the end of twenty years there will be 2,000 meters in service, as follows:

4-inch meters,	10, at	$200	$ 2,000
3-inch "	20, at	100	2,000
2-inch "	30, at	60	1,800
1½-inch "	40, at	40	1,600
1-inch "	100, at	25	2,500
¾-inch "	200, at	20	4,000
½-inch "	1600, at	13	20,800
Total	2000		$34,700

Or an average for each meter of $17 35
Add for setting..... 65

Total cost of each meter and setting $18 00
The cost of meters may then be represented as follows:

Amount to be placed at compound interest each year for each meter at 5 per cent, so that the several principals and interests will together equal the original cost of the meter and its setting at end of 12 years..$1 08
Yearly interest on cost of each meter and its setting..... 90
Yearly cost of repairs for each meter 32

Amount to be placed at interest each year for each meter, so that at end of period the whole charges on account of meters shall be accumulated $2 30

The following table will show in detail the cost of these meters at end of 20 years, being the time when the whole capacity of the works will have been reached under the "Schedule Rate" plan of selling the water:

TABLE SHOWING COST OF METERS AND INTEREST AT END OF TWENTY YEARS.

Number of Meters set each year.	Am't set apart for each Meter each year, to be compounded at 5 per cent.	Tot'l am't set apart each year for all Meters set, to be compounded at 5 per cent.	Number of yrs. in period for which interest is compounded at 5 per cent.	Total am't of principal and interest at end of 20 years.
	Dollars.	*Dollars.*		*Dollars.*
100	$2 30	$ 230	20	$ 610
100	2 30	460	19	1,164
100	2 30	690	18	1,663
100	2 30	920	17	2,107
100	2 30	1,150	16	2,507
100	2 30	1,380	15	2,870
100	2 30	1,610	14	3,188
100	2 30	1,840	13	3,459
100	2 30	2,070	12	3,726
100	2 30	2,300	11	3,933
100	2 30	2,530	10	4,124
100	2 30	2,760	9	4,278
100	2 30	2,990	8	4,425
100	2 30	3,220	7	4,540
100	2 30	3,450	6	4,623
100	2 30	3,680	5	4,710
100	2 30	3,910	4	4,770
100	2 30	4,140	3	4,802
100	2 30	4,370	2	4,807
100	2 30	4,600	1	4,830
2000		$48,300		$71,136

It will thus appear in the case used as an illustration, that at the end

of 20 years, under the "Schedule Rate" plan, the total water supply as originally provided will be used daily, and a duplication of the water works plant must be made. And this period will come much sooner than 20 years if, as is probable, more than 100 gallons per capita per day shall be used, while under the meter plan there would remain at the end of 20 years one-half of the whole supply unused, or sufficient for a future supply for 20 years, provided the same rate of increase of population be maintained, and this, including compound interest at 5 per cent, at a cost to the consumer of $71,136, or at a cost, not including interest, of $48,300. The larger sum, if collected of the consumer by an addition to his rates, would amount to about one-quarter of a cent per 100 gallons, and the owner of the works would have received at the end of the 20 years all the meters would have cost him up to that time, including interest.

The cost of the duplication of a set of water works cannot of course be determined without a full knowledge of all the peculiar conditions which may obtain at the particular locality, and therefore only a few general suggestions can be made, which may assist in forming a definite opinion as to the comparative cost of a general use of meters and that of a duplication of the works at the end of say, 20 years.

Neither is it claimed by the writer, that exactly similar results to those of the case used as an illustration will follow in all cases, but the following suggestions may assist in a correct judgment as to whether the method is logical, and whether even better results may not follow in most cases than in the hypothetical case used as an illustration.

(1). The owner receives full compensation for all he expends in procuring and furnishing the article sold, and the buyer pays for just the amount of goods procured and used, and no more or less, and exact justtice obtains in each case.

(2). In the case of pumping works it can be readily seen that the saving by the use of meters will be very great in 20 years. In the case used as an illustration it may be approximately estimated as follows:

The cost of pumping for small works, like those in question, may be taken at nine dollars per one million gallons raised one hundred and fifty feet high.

Average daily pumping on the Schedule Rate plan equals 500,000 gallons at $9 per million 150 feet high.....$4 50
Average daily pumping on the Meter plan 225,000 gallons at $9 per million raised 150 feet high..... 2 25

Daily saving on the Meter plan.....$2 25

This saving of $2.25 daily for 20 years, together with compound interest on the several yearly savings, would amount to $25,414, and would thus reduce the meter account for the same period from $71,136 to $45,722.

(3). In the original construction of water works, whether by a private company or a municipality, the cheapest and most available source is usually selected, and in very many cases the provision made requires all the water which that particular source will furnish, so that when the time arrives for duplicating the amount of water to be furnished, more distant sources must be sought, involving large preliminary expenditures, often in excess of the original cost. In such cases it can be readily seen

that the general use of meters, by which the time for which the original provision is adequate is indefinitely prolonged, is the cheaper plan.

(4). I think it may be fairly assumed that in all but exceptional cases the cost of a duplication of an original water supply will be approximately three-quarters of the amount originally expended in the construction of the first plant, and if the case used as an illustration is at all general in its application, as is believed, then the meter system of sale is the cheaper.

(5). It has been stated in a preceding portion of this paper that the tendency under the "Schedule Rate" plan is toward a more extravagant use of water, which tendency, if not in some way checked, will soon reach an average of perhaps 150 or more gallons per day, per capita of population, and works which were intended to have adequate capacity for twenty years will require reconstruction in ten to fifteen years. This tendency emphasizes the saving by the meter system.

(6). The water works manager is cognizant of this tendency to extravagant use by its consumers, and in self-defense makes such an adjustment of schedule rates as will save him from direct loss, even if the use of water amounts to 150 gallons per capita. In this way the conscientious consumer is made to suffer for the sins of his neighbor, and both are encouraged in the waste of potable water, which is rapidly becoming a scarce commodity, and therefore more and more difficult and expensive in its procurement.

(7). The tendency of demand is towards the production of a cheaper meter. Inventors all over the world are engaged in attempts to produce a meter which shall combine *cheapness* with accuracy and durability. Insomuch as they are successful in this, to that extent also will the financial economy of the meter system be manifest in the future.

In the foregoing discussion, it will be observed that the writer has confined his remarks exclusively to the effect of the meter system as applied to new works, but he is clearly of the opinion that similar results would follow its judicious application to existing works.

In the case of old works, in order to avoid too large an expenditure at any one moment, it might be advisable to place such a number of meters each year in excess of the yearly increase in the number of new services attached as would in say, ten years, result in a general metering of all.

In conclusion, it is fair to state that it is not claimed that the foregoing is in any wise an exhaustive treatment of the subject, but is intended rather, by the suggestions made, to induce independent thinking and investigation by the army of experienced and interested persons connected with water supply and management.

J. Nelson Tubbs.

The President: I have just received a communication from Mr. Edward J. Paxon, of Philadelphia. (Reads letter.)

Edward J. Paxon, Architect,
Philadelphia, April 14th, 1891.

President American Water Congress, Parlor "C" Continental Hotel.

Dear Sir: I enclose a type-written copy of suggestions prepared for presentation to *Joint Committee* or *Water Supply*—select and common

councils—advocating a High Pressure Supply for service and fire protection in the centre of city, which I place before you at this time, thinking that being directly in the line of thought in which you are at present working it may be of interest to the members of the Congress, and worthy of consideration and discussion by the specialists now assembled.

Very truly yours,

EDWARD J. PAXON.

On motion, the paper presented by Mr. Paxon was referred to the Executive Committee.

THE PRESIDENT: The Secretary says he has a paper by Mr. B. F. Jones, on Hydraulic Elevators. He says the paper is a short one. Will you hear it read to you? I don't know how the Association feels about reading any more papers this afternoon.

A motion to adjourn was made and seconded.

THE PRESIDENT: The motion to adjourn is now before the convention.

Are you ready for the question on adjournment?

Motion passed.

SECOND DAY.

MORNING SESSION, 10 a. m., Wed., Apr. 15, 1891.

THE PRESIDENT: The first business before the Convention this morning is some applicants for membership.

The Secretary then announced the names of the following applicants for membership.

FOR ACTIVE MEMBERSHIP.

Jno. B. Hawley, Constructing Engineer.....St. Paul, Minn.
Hon. Geo. Hillyear, Water Commissioner.....Atlanta, Ga.
Robt. Surtees, Sec'y Water Works.....Ottawa, Canada.

FOR ASSOCIATE MEMBERSHIP.

Morris Tasker & Co.....Philadelphia, Pa.
The Brass & Iron Works Co.....Fostoria, Ohio.
Walworth M'f'g Co.....Boston, Mass.
Wheeling Water Works.....Wheeling, W. Va.

THE PRESIDENT: You have heard these applications, gentlemen, what shall we do with them?

A motion was made that the rules be suspended and the applications considered. Motion seconded and passed without dissent.

THE PRESIDENT: I am glad to welcome our Canadian brothers, to tempt them across the line as far as possible. I am glad that we can promote reciprocity in this respect. (Laughter and applause.)

THE PRESIDENT: The Secretary has some communications to read to you.

THE MASTER BUILDERS' EXCHANGE,
PHILADELPHIA, April 11th, 1891.

Mr. John Birkinbine, No. 25 Juniper St., Phila.

DEAR SIR: We are informed that you are Chairman of the Committee on Reception to the American Water Works Association which will hold a convention at the Continental Hotel, next week, from the 14th to the 17th inst.

I am directed by the Committee on Exhibition Department of this Exchange to extend to the members of that Association and their friends through you, a special invitation to visit our Builders' Exchange Permanent Exhibition during their stay in this city.

The exhibition is open free to the public every day (Sunday excepted) from 8 a. m. to 5 p. m. Should those hours not suit the convenience of yourself and guests, however, we should be equally as well pleased to have them call upon us at a later hour of the day or evening, in which case kindly apprise us of the hour of your coming.

We should be particularly gratified to have your Association accept this invitation as our exhibition, is certainly very interesting and instructive, particularly to anyone connected, as your members are, with the planning and erection of buildings and who are thereby brought closely in contact with the use of building materials. Trusting, therefore, that you will be enabled to include us in the program arranged for your guests during their stay in Philadelphia, I remain,

Very sincerely yours,
WM. W. MORGAN,
Supt. Exhibition Department.

THE WILLIAM CRAMP & SONS SHIP & ENGINE BUILDING CO.,
PHILADELPHIA, April 13th, 1891.

DEAR SIR: We desire to have you extend to the Engineers of the Water Works of the United States an invitation to visit our works on Saturday at whatever hour may best suit their pleasure.

If you will kindly let us know what time we can expect them, we shall take pleasure in having a tug boat meet them at Walnut street wharf to convey them to our works. Yours truly,

THE WM. CRAMP & SONS SHIP & BUILDING CO.,
W. M. CRAMP, Vice-President.

WALTER WOOD, ESQ.,
Philadelphia.

UNITED STATES DEPARTMENT OF AGRICULTURE,
FORESTRY DIVISION,
WASHINGTON, D. C., August 12, 1890.

J. M Diven, Esq., Secretary American Water Works Association, Elmira, New York.

DEAR SIR: In sending for use of your Association two copies of Bulletin four, from this Division, containing Mr. Tratman's report on Metal Track, I hope more directly to enlist your Association in the general forestry question.

Will you please exhibit the publication at your next meeting and announce, that, upon application to this Division, members of your Association will be supplied with copies. Respectfully,

B. E. FERNAW,
Chief of Forestry Division.

THE PRESIDENT: What will you do with these communications, gentlemen? All these communications it seems to me need special acknowledgment. We are not disposed to pass over in silence any courtesies, and it will undoubtedly be a great privilege to visit the great firm of Wm. Cramp & Sons.

MR. HAYNES: If it does not interfere with any prearranged programme, I think it would be a very good idea to visit Cramp's shipyard.

THE PRESIDENT: Suppose it be left to the Executive Committee, Mr. Haynes.

On motion the communications were referred to the Executive Committee.

THE PRESIDENT: Mr. Gardner has a commuication to present from the Executive Committee.

MR. GARDNER: The Executive Committee recommend the passage of the following resolution:

Resolved, That Section 2, of Article 3, of the Constitution of this Association be amended by the addition of the following paragraph:

Provided any Active member of this Association who by change in

his vocation is now engaged in duties which would place him in the class of Associate member, were he now to apply for membership, may continue as an Active member with all the privileges of that class, with the exception that he shall not be eligible to any office in the Association while thus engaged.

There was present at the meeting of the committee a member of the New England Water Works Association, who contemplate action similar to ours, and we are assured that our action in this matter will be the action of the New England Association.

THE PRESIDENT: I move the adoption of the resolution.

Motion seconded.

MR. BENZENBERG: Mr. President, it seems to me that an entire change might occur with an active member, he might retire from water works business altogether and at the same time not become associated with any firm which would permit him to become an associate member. There is no provision in the constitution for his standing. It seems to me all the words after "vocation" should be stricken out and then covered in some way so as to permit a member to change his vocation without affecting his standing in the order.

MR. BENZENBERG: Mr. Gardner's provision covers the case only when he has changed his vocation in such a way as to admit him as an associate member. I offer as a substitute for Mr. Gardner's resolution the following:

"Any active member of this Association who may at any time change his vocation may continue as an active member, with all the privileges of that class, with the exception that he shall not be eligible to any office in the Association while thus engaged."

MR. GARDNER: On the part of the Executive Committee I accept the substitute.

THE PRESIDENT: Are there any remarks?

Motion passed unanimously.

THE PRESIDENT: The first regular business before the Convention this morning will be the reading of a paper upon Water Works Securities by Mr. Reinecke.

MR. REINECKE: Gentlemen—When I first began the preparation of this paper I thought I would be able to exhaust the subject within the reasonable limit which may be given to such a paper, but I soon found I had at least three or four subjects which you will readily perceive as my paper progresses and which will probably require more elaborate treatment at some future time. And so I have preferred to give you a mere analysis of the whole subject.

WATER WORKS SECURITIES.

WILLIAM REINECKE, LOUISVILLE, KY.

The subject of water works securities, upon which I have been invited to address you, is of constantly increasing importance. While the youngest among us, probably, had already begun his business career when the first water works bond was taken as an investment by a financial institution in this country, ever since that time the circle of investors who hold such bonds has been steadily and surely widening. Only a few days ago, in looking at the list of assets of one of the oldest and most conservative life insurance companies in this country, the home office of which is in this staunch and conservative city, I observed the notable fact that it is holding about one and one-half million dollars of water works securities. Surely, it must be of interest to study and determine the causes which have brought about such a remarkable change.

It is a trite truth that speculators and investors cannot live in the same atmosphere. They aim at wholly different things. The investor seeks a steady market; he looks for securities fluctuating in price as little as possible, with the changes in quotations governed solely by changes which have occurred in the value of the property. On the contrary, the speculator looks above all things for rapid changes in the prices of securities; foreseen, perhaps largely influenced by himself, but in the nature of surprises and routs for the general public. Investors stand in the place of consumers; they buy what they need, and that only which they have selected as safe to keep. Speculators buy and sell vast quantities, enough to control the price, and solely to that end, to the utter defeat of all legitimate dealing. It follows that the power of the speculator largely overshadows that of the investor. To illustrate: Mr. Vanderbilt was supposed to hold in the year 1881 fifty million dollars of government bonds. Supposing a dealer to use such a fortune as a margin in speculation, he would absolutely control fully one-half of all the stocks dealt in at the New York Stock Exchange, in par value five hundred million dollars or more; and no combination of investors could be formed sufficiently powerful to resist such a gigantic grasp. Thus it is, to borrow the words of William M. Grosvenor, that the speculator plays against the man who owns the property, and with loaded dice.

The conclusion would seem to be warranted that whatever securities are in the power of speculators, or may be subjected to their control, must for that reason be regarded as unsound for investors. If there be

any good left in railway stocks, it must be largely attributed to the fact that about one-half of them have never been active in speculation. But were the disasters brought on by stock gambling confined to the speculators themselves, the rest of the world might regard their operations with the same equanimity with which we receive the news of the result of a fierce contest between their ignobler brethren of the green cloth. Such practical lessons, however, as the experience of the year 1884 teach us that investors are seriously and fatally affected by the manipulations of the stock list on the part of speculators. Take such a stock as Chicago & Northwestern, yesterday quoted at 107¼. During the year 1891 its fluctuations have been from 102⅛ to 108½. February 16, 1884, its price was 122¾; December 27th of the same year it was 82⅜. Delaware & Hudson, yesterday quoted at 134, has ranged in the year 1891 from 129¼ to 139⅝. February 9, 1884, it stood at 113⅜; December 31st of the same year at 68. Western Union, yesterday quoted at 81½, has ranged in the year 1891 from 76 to 82⅜. January 5, 1884, it stood at 76; December 31st of the same year at 54. When such immense shrinkages occur, amounting to from thirty to forty per centum of the face value of all the stock of the railway system of the whole country, we can very well understand why thousands of persons who never speculate at all, began the year 1884 as men with princely fortunes, and ended it as paupers.

It is plain that mortgages, excepting those of the majority of railways, are, generally speaking, beyond the reach of speculation, because beyond its aim. Hence a large class of investors, corporations as well as individuals, took kindly to farm mortgages, especially such of the Western States, in which abundant harvests and a large influx of new settlers for a time contradicted the terse epigram of Salmon P. Chase: "High interest means bad security." But a change has come over the farm mortgage business, notwithstanding its concomitant props of debentures and guarantees; and when it is known that a single law firm in a Western State has at the present time sixteen hundred farm loan foreclosure suits pending in the courts, and when the consequent state of public feeling in the communities thus affected is considered, we may regard the bottom to have pretty well fallen out.

Nor do mortgages upon new manufacturing establishments, or upon canals, coal mines or furnaces offer a much more inviting field, for cases have been superabundant where the mortgagor had failed in the undertaking, and when the plant was about to be sold under the hammer, at perhaps one-tenth only of its cost, that the capitalist who had invested in the mortgage was reduced to the sorry choice between the purchase of an elephant and the worry to take care of it after it was bought, or, on the other hand, the certainty of being "frozen out."

In one respect water works bonds stand upon a plane quite distinct and individual. A water company dispenses to the public an article of paramount necessity to the whole community, and not to be displaced by any new invention. Gas companies may suffer by the competition of the electric light, or by the introduction of a superior product which science may yet win from petroleum. But it is impossible for the imagination to conceive an article which could be a substitute for water. It may be costly to procure for a city by the erection of water works a sufficient supply of pure water, but surely the individual citizen is served more cheaply by becoming a consumer of the water company than by his

own efforts to supply himself. And since the public health largely depends upon pure water, and because a well equipped water company by its fire hydrants can and does give to the people a fire service more economical than that from fire cisterns, yea, vastly superior in kind and quantity to steam fire engines, the people at large have in a water company an interest as tangible and as real as that of the stockholders. The community may not draw any dividends from the distributable profits of the company, but each and every taxpayer has already received his dividend in the reduction of the insurance rate upon his property, in enhanced security against damage by fire, and in greatly increased comfort of living. It may truly be said that a first-class fire in a city will pay the total cost of the erection of first-class water works; and just as truly that in some instances the annual decrease in fire insurance premiums caused by the introduction of water works, will equal, if not exceed, the gross annual revenue of the water company.

Hence it is that a water company is enabled to start out invariably under the protection of a contract with the municipality for fire hydrants. In an experience of nearly twenty years as the counsel of water works builders and as an officer of water companies, I do not remember an instance where the rental of fire hydrants contracted to be paid by the municipality fell short of the ordinary current interest upon the total cost of the works. Nor should this be regarded as excessive, for it must be borne in mind that, eliminating this revenue for hydrants from the calculation, the operating expenses have to be met from the beginning by the revenue from private consumers—a result too often attained more easily by making estimates beforehand on paper, than *ex post facto* by adding up actual collections.

But whether there be at the beginning a deficit on this score or not, the rule is universal: A house once connected with the water works will remain on the list of consumers unless temporarily vacant or shut off for failure to pay the rate. Water works, therefore, are not only a productive investment from their very completion, but their productiveness is unfailingly and steadily on the increase. Where there were in the beginning two, four or six consumers to a block, especially in towns laid out on a generous scale of expansion and not densely settled, the population which fills the gaps will soon increase the revenue from the block at a wonderful rate, and without the expenditure of a dollar excepting for connecting the new consumers. It is this reserve force which distinguishes most significantly a new water works plant from any kindred enterprise, and which makes it absolutely and unvaryingly certain that the revenue of a water company, instead of ever falling off as time passes on, or as panics and financial disasters sweep the country, is at its lowest ebb in the beginning. This element, and the fact that a water company is not burdened with bad debts, because it collects its rates in advance, are differences of such moment for the prosperity and stability of the venture, that they cannot be ignored.

The durability of the plant of a water company likewise deserves mention. The mains of well equipped water works are quite generally constructed of cast iron, and they are deeply buried into the earth, far removed from danger by fire or other disturbing causes. They are known to last for centuries, and they need never be removed except to give place possibly to mains of larger diameter. If the buildings are not absolutely

fire-proof in all cases, at any rate they enjoy exceptional facilities for extinguishing a fire. The machinery will last for many years with reasonable care, and so the annual ratio of deterioration is remarkably light.

And, lastly, a water company, whether its franchise be exclusive in its terms or not, has to all intents and purposes a practical monopoly in its business. The contract with the municipality runs in nearly all cases for a long term of years, and while it lasts there is naturally no room for any competing venture. It is true that at the end of this time another water company might spring into existence, and might take the hydrant contract with the city away from the old company; but this would be a barren conquest, for the victor could not hope to live, unless it should also win over bodily the array of private consumers whom the old company has already supplied for many years. In the light of the past experience of water companies such a contingency is but an idle dream. I know of no case in which two existing water companies have ever contended for business in the same territory. Even in the city of London, which is supplied by quite a number of water companies, each of them is established for a distinct locality to which it confines its business, and paralleling is unknown.

It is true, a water company may get into a wrangle with the municipality. As the sweet singer of the old dog-eared primer has it,

> "Now we come to the Jewish nation;
> Trouble, trial and tribulation."

Nations and States have defaulted; even a city may stop payment. For some reason, good, bad or indifferent—I recall instances of all three of them—the city may refuse to use the fire hydrants and may call a halt on the further liquidation of rentals. Such a course brings about a sorry situation for the water company, but a still sorrier one for the city. Of course the ancient fire service has now to be rigged up again, as it existed in the time of the forefathers, and as it was jubilantly abandoned when the water works were completed. The insurance companies are first puzzled; all at once they are staggered by a smart increase in fire losses. Next they raise the rates all along the line. The people howl. This delectable state of affairs continues until finally public opinion exercises sufficient pressure to bring all the high contracting parties to their sober second thought. The trouble is patched up, and once more the municipal roaring lion lies down to peaceful repose with the more or less innocent water works lamb.

Having thus reviewed the principal and controlling considerations which affect water works securities, I think that sufficient reasons have been shown for the increasing favor with which they are regarded by circumspect investors in these latter days, and which is reflected in the prices which they bring. I remember the sale in the year 1876 at 92 % of $900,000 of first mortgage six per centum thirty year bonds of the Louisville Water Company, the stock in which belongs to the city of Louisville. The same bonds, after one-half of their term has already been spent, now sell for 117½ and interest. A second mortgage of $500,000 on the same works, although bearing five per centum only and running twenty years, is selling at 103½ and interest. I also remember the sale, ten years ago, of an issue of six per centum first mortgage bonds of a water company in which I was interested, at 90, and their redemption

by the company before maturity for cancellation at 108. Similar experiences abound in every direction.

But is there any reason to apprehend any danger or detriment to the market for legitimate securities of this description, on account of the tendency of the business, by the infinite multiplication of water works all over the country and in the most unexpected spots, as what I might call commercial ventures? Let me illustrate.

Follow me to a little town somewhere or other, it matters not where. Whether it nestles in the smiling valley of the sunny Susquehanna or under the beetling peaks of the snow-capped Cascade Mountains; whether its feet are bathed by the cool waters of Lake Superior or by the majestic sweep of the tides of the Mexican gulf, it points the same moral, if it does not adorn the tale. Call it Podunk, for short. Whether it be a thing of beauty, or not, at any rate the loyal Podunkians love it and toil for it, and it makes all the noise in the world which it can make. The noise may be produced by the cheerful buzz of a hundred busy factories, or we may merely hear the resounding kicks with which Podunkian civilization hoists the noble Indian into a remoter sphere of usefulness, over the graveyard-like array of stumps which still diversify the monotony of Podunkian thoroughfares. The town has no more than two or three thousand inhabitants, let us say, but it feels in its sinewy arms the growing pains of a young Chicago. Perhaps it has just passed through an excited local canvass, with the political party lines strongly drawn from governor down to deputy constable, through which battle the triumphant set of politicians has borne aloft a gorgeous banner displaying emblazoned in golden letters the proud war-cry: "Give us metropolitan comforts, or give us death." Away with coal oil lamps, away with cistern water; give us street cars, telephones, electric lights, messenger service, public parks, granite streets, but above all give us water works. By virtue of a solemn resolution of the city council, his honor the mayor advertises far and wide for proposals to erect water works, either for the city of Podunk or under a franchise. There may be no more water within five miles than the popular city horse pond, not deep enough to duck a full grown witch; there may be serious doubts regarding the legal right of the municipality to grant a water works franchise or to contract any liability in addition to existing debts; there may not be fifty consumers of water in sight, and not a single one willing and able to pay exceeding fifteen dollars per annum. But do such little difficulties make any serious difference; do they deter sanguine projectors from making bids, from laying siege to the mayor, to the councilmen, to all the shining lights of the town, in sober truth to the whole community? Ah, my friends, do not we remember? Have we not been through this experience, time and again—pipe founders, machine builders, engineers, professional "water workers," and all? Have we not arrayed household against household, nation against nation, newspaper against newspaper, kingdom against kingdom? The reservoir system against the standpipe system, and the Holly system against both? Has not ours been always the only true, the only admirable, the only reasonable, the only honest water works scheme for that blessed community of Podunk? Even in the weary watches of the night and from the very housetops, aye, out of the mouths of the Podunkian babes and sucklings, we have heard reverberate the fierce strife between the standpipe and the Holly systems, which like a canker

had eaten into the very heart of the community and which our artful eloquence had fomented? Yea, and worse! After having reaped in such a conflict the curse of victory, have we not piled a Pelion upon the Ossa of our rashness by actually building the Podunkian water works, against all prudence and against all reason? Have we not built better, and larger, and more expensive works than Podunk can afford or will be entitled to for the next twenty years, simply as the outcome of a mad scramble amid an army of competitors for an apple which when we were finally permitted to call it our own, proved to our soberer contemplation rotten to the core?

We may yet count upon the fingers of one hand all the failures of completed water works which have ever occurred in this country. In one case the highest court of the State decided that the municipality had exceeded its delegated powers by attempting to make a contract for hydrant service; in another the franchise was annulled by the city on the ground that the water was discovered to be from another source than that stipulated for in the contract; in a third case it was demonstrated at the tail end of the official test of the works that the water company could not throw two fire streams one hundred feet high from the head of a long single line of four-inch pipe terminating on the top of a hill. But these instances do not make against water works bonds. If any bondholders were involved in these cases, and if they suffered, they may justly blame their own imprudence. But the vice of Podunkian ventures is a present insufficiency of revenue and the absence of reasonable hopes for the future to better the condition. Water companies are not managed as eleemosynary institutions. They must have a competence of income to sustain life, or they will certainly die of inanition. But let bonds of such ventures get into circulation and the fair fame of water works securities will soon be destroyed.

In addition, therefore, to the ordinary commercial and financial safeguards which affect all bond negotiations, and without attempting to treat of bonds issued by well established companies in large cities, I would lay down the following as imperative and controlling conditions for the purchase of the first bond issue of recently established companies, these being the bonds which seek the general market:

1. The legal authority of the municipality to grant the water works franchise and to enter into the contract for fire service, and its ability to pay the stipulated rentals should be shown.

2. The construction of the water works should have been completed, and they should have been accepted by the city as conforming in structure and efficiency to the conditions of the contract.

3. The annual interest upon the bonds should not exceed the sum payable annually by the municipality for fire service, and the city rentals should be assigned to be collected by a trustee for the benefit of the bondholders.

4. The bond issue should not exceed the actual cost of the construction of the water works.

5. A sufficiency of other revenue from existing consumers should be shown to cover all operating and managing expenses, repairs and taxes.

6. The mortgage should regulate the subsequent issue of additional bonds to pay for pipe extensions, and should require a reasonable exhibit

of sufficient revenue from the proposed extension to keep down at least the interest upon the bonds so issued.

7. The bonds should mature before the expiration of the hydrant contract.

These points being well guarded, water works securities will continue to stand upon that high plane of excellence which they now occupy, instead of becoming a menace to the welfare and reputation of this ancient and honorable craft.

THE PRESIDENT: The paper is open for discussion. The Secretary informs me that he has been trying to get this paper before our Association for three years. I am satisfied that the time we have spent in waiting has been well repaid.

Are there any remarks following the reading of this paper? I don't think we will have any paper so full of allusions which are of such personal interest to all the members.

If there are no remarks we will proceed with the reading of the next paper, "Water Works Notes," by Charles R. Brush.

MR. BRUSH: The paper that has just been read by Mr. Reinecke is too important for off-hand or hurried consideration. I am not surprised that there has been some hesitation in discussing a paper presenting such vital questions. I think some of the positions taken, however, invite criticism. One of these is that the bonds of the company ought to be entirely protected by the hydrant rentals. To a great extent this has been practicable in the past, but I doubt whether such will be the case in the future. If investors will not take water works bonds unless they are so guaranteed, I fear it will be difficult to place them. I believe in the future water companies, and cities will have to rely on more improved and economical methods of operation and increased revenue from consumers rather than excessive hydrant rentals.

AERATION ON A GRAVITY WATER SUPPLY.

BY CHARLES B. BRUSH.

During the past year I was called upon to advise in relation to the water supply of a small town, which supply was unique in several important particulars. The property and plant of the water company was practically owned by one individual—a wealthy, busy gentleman, who took up the question as a recreation, and in fact made it his hobby.

A dam about twenty feet high had been thrown across the stream and a large amount of water impounded in an artificial lake. The company purchased several hundred acres of surrounding land, tore down some twenty or thirty dwellings, and laid out the ground around the lake in a beautiful park. Everything in the nature of pollution along the banks of the stream emptying into the lake was carefully removed. The capacity of the lake is about 100,000,000 gallons, and the daily draught therefrom about 200,000 gallons; hence the capacity of the lake is 500 times the average daily draught. The quality of the water is generally quite satisfactory, but at times algæ appeared in the water, with its usual accompaniment of an unpleasant taste and smell. As it was apparent that the difficulty arose from the unusual fact that the works had been built too large for the consumption, the first thing done was to waste the water into a miniature lake at the foot of the dam, and also through a large number of neat little fountains in different parts of the town. The water thus wasted was taken from the top, middle and bottom of the lake. This action afforded an immediate and very great relief, but it was only partially successful.

I then determined to resort to aeration, which personal experience during the last seven years has caused me to regard with sincere respect. I believe all waters are in their best condition when in motion. I believe that forcing air into water improves its condition, both by increasing the amount of oxygen in solution in the water and by keeping the water in motion. Under these conditions water cannot stagnate, and different forms of bacteria and algæ, which are often so offensive, cannot exist. I believe that it is impracticable to physically remove this animal and vegetable life. Their existence indicates an unsatisfactory condition of the water which should be cured, and when the disease is cured these friendly danger signals will disappear.

The question therefore arose as to the best and most economical method of aerating this supply. As there was no steam power at hand, I determined to make the water aerate itself. The water main from the reservoir to the town descends for a distance of about 400 feet and then ascends for a distance of about 1,100 feet, passing over a summit through a large equalizing tank about 25 feet in height, the flow line of which is on the same level as the reservoir. A 12-inch pipe was laid from the gate house at the lake down the valley for a distance of 350 feet to within fifty feet of the lowest point of the main. Here was set up a 10-inch double discharge Leffel turbine wheel, connected with a small Clayton compressor. The gates were arranged on the 10-inch turbine so as to make it equivalent to a 6¾-inch wheel. The compressor was single acting, 5 inches in diameter and 6-inch stroke. When the water was turned on to the wheel the air was forced into the main by the compressor. This air forced its way against the water flowing through the main and rose toward the lake, coming up through the gate house in great volumes and agitating the water therein with considerable violence. The water thus aerated immediately lost its taste and smell and the result was entirely satisfactory.

The head of the water on the turbine is 32.5 feet, equivalent to 14.07 pounds per square inch. The air is forced into the main under a pressure of 20 pounds per square inch. It requires 3.15 cubic feet of water to operate the wheel under the head of 14.07 pounds in order to force one

cubic foot of air into the main against the pressure of 20 pounds. It requires 259,000 gallons of water in twenty-four hours to run the turbine so as to enable the compressor to force 82,250 gallons of air into the 200,000 gallons of water supplied from the lake to the town. But this 259,000 gallons of water thus used as power in this case would have to be wasted in any event, so the motive power costs practically nothing.

The horse power from the water used is 1.23; the horse power from work done is 0.67. Hence the efficiency of the plant is about 45 %.

The cost of operation is nominal—a little oil and a few minutes of the gate keeper's time each day.

The matter is presented as a practical illustration of one method of utilizing the forces of nature for the welfare and convenience of man.

THE PRESIDENT: Are there any remarks, gentlemen, upon this very interesting paper?

THE SECRETARY: Is that a patented process, Mr. Brush?

MR. BRUSH: The introduction of air into water has been practiced for many years on cisterns and wells. The application of this principle of forcing air into water under pressure for the purpose of purifying the water has been patented.

A MEMBER: What was the length of the main?

MR. BRUSH: The length of main referred to in my paper, from the turbine to the gate house, is 350 feet.

MR. FISH: I would like to know something about these algæ; the appearance they present and what they are an indication of.

MR. BRUSH: There are different kinds of algæ. Some indicate an offensive condition of the water and others do not. As a rule they indicate that the water is going through a purging process. This is something which all waters go through in some form or other at different times. Often the algæ has the appearance of green paint. When it first appeared on a reservoir under my charge I endeavored to physically remove it. This proved to be impracticable. I am of the opinion that it is impossible to mechanically remove algæ from water.

MR. FISH: My question is: I am trying to find out what the algæ is, whether it indicates an impure condition of the water. I have got it in my head that this

green stuff you speak of is not an impurity. You will find it in the best live springs where the water is always good. Is that the case?

Mr. Brush: The algæ to which you refer may be entirely harmless. Personally I am not prepared to discuss the biological and chemical aspects of the question. A very exhaustive paper by Mr. Rafter in that line has just been published in the last report of the State Board of Health of New Jersey.

The President: I would like to ask whether the passage of the air from the compressors to the reservoir charges the water with air so as to form bubbles? Whether the passage of the air interferes with the passage of the water?

Mr. Brush: It does not seem to do so to any appreciable extent.

The President: Does the air collect in bubbles?

Mr. Brush: The air does collect at the pipe summits, but not to a serious extent. The accumulation is blown off from time to time when necessary through air cocks.

The President: Is your system only applicable to a straight line of pipe?

Mr. Brush: I have applied this system of aeration to the force mains of the Hackensack Water Company for seven years past. One of these mains is fifteen miles long and the other sixteen miles. They have numerous horizontal curves and angles. They are not laid on any regular grade and they do pass over many summits, some of which are 75 feet in height. We blow off these summits perhaps once a month.

The President: Has any other gentleman got any inquiries to make of Mr. Brush before he takes his seat?

The next paper, gentlemen, is by Mr. Charles A. Hague, upon the value of pressure records in connection with water works.

Mr. Hague: Mr. President—Gentlemen—I have been something of a crank for the past three or four years

upon the subject of knowing what is going on inside of steam or water pipes, just the same as we have found out what is going on inside the steam cylinder by the use of the indicator, and thinking on the subject has gradually brought about this paper.

VALUE OF PRESSURE RECORDS IN CONNECTION WITH WATER WORKS.

A consideration of modern tendencies in the development of this great republic leads inevitably to the conclusion that its progress is along the lines of scientific advancement. Perhaps in no particular is this more true than in its application to the attention given to sanitary and fire protection problems—for what is more important than the protection of life and property? Therefore, of late years water works systems have increased at a rapid ratio. That this growth has been a healthy one is evidenced by the attention given to the subject of their betterment, no other proof of which is needed than that furnished in the popularity of our annual gatherings for the interchange of thought and mutual tender of data, most of which becomes of lasting value in our published proceedings. In considering the many relations existing between the water boards or companies and their patrons, and the municipality under which they exist, and not forgetting that important creature the fire underwriter (whose fire loss is not his, but ours), I have become forcibly impressed with the gravity of an oversight quite common even among the most conservative of our water works systems, and which is suggested by the title to this paper I have the honor to present for your judgment. The writer has observed for a number of years the construction, operation and extension of water works plants for public supply, and has arrived at the conclusion that the great importance of a continuous, complete knowledge of the pressure being maintained throughout every part of a water works system is in the interest of water companies, cities, taxpayers and fire underwriters; in the interest of health; in the interest of safety; and in no manner can such information be obtained other than by automatically and continuously written pressure records, produced at various points of observation at the same time. Broadly stated, it would seem to be true, that as water works systems imply quantity and pressure, complete data regarding them is required. The quantity factor is determined nearly enough by the revolution counter attached to the engine in a large majority of cases, but the other feature is not, although the two are inter-dependent for maximum efficiency. In laying out, or in extending a system of pipes, care is taken, of course, to so proportion and arrange them as to give the most efficient distribution for domestic, manufacturing and fire service; and as each case is peculiar to itself, according to the area of section to be covered, general levels and special conditions, the success depends upon many calculations, which in the nature of the undertakings, are more or less theoretical, and not to be exactly determined until the works are in operation. Bearing upon this particular point, Mr. Edwin Darling, Superintendent of the Pawtucket, R. I., Water Works, says in his report for 1889 as follows: "No well conducted water works can afford to be without recording gauges, and

when properly located, they will in my opinion pay for themselves within one year. We challenge any water works in the United States to play seventy one-inch fire streams through fifty feet of hose and maintain eighty pounds pressure during the trial; the pressure to be verified by recording gauges placed at suitable positions on the line of pipe."

Further, even when the construction and distribution are practically correct to meet the conditions originally imposed, the rapid and ceaseless growth of American cities presents a never-ending necessity for change and readjustment. One portion of a city or village will, although unforeseen, be found to be possessed of desirable features as a manufacturing center, increasing the demand for water, both for domestic and fire service, entirely beyond any extent looked for when the plant was devised. Such a state of things in the absence of records will be most certain to bring us very readily and suddenly, at some time or other, in contact with the disagreeable and dangerous fact that the distributing system is entirely inadequate to meet the demands for water, but if we are provided with means for observing from day to day, continuous and recorded evidence, to which we can turn back and refer, ample time will be found to become possessed of a complete knowledge of the requirements, and the most effective manner of meeting all demands will be indicated.

In another section of a city, perhaps limited to comparatively a few squares, the commercial and similar interests may become concentrated in lofty office buildings, while another portion, quite remote, may be devoted to a thickly settled population; all such occurrences modifying the efficiency, or reliability, of a water plant, laid out with the idea of uniform distribution of water. We may not want uniform distribution, but, on the contrary, a very uneven disposal of the supply; we can, to be sure, when we meet unexpected difficulties and dangers, make some attempts in the dark towards a remedy, but how much better to have a graphic indication of the giant's pulse always before the eye, so that undue congestion or an approach to heart failure may be known and met long before any serious results are possible.

One twelve story building in our larger cities may need an amount of water usually allotted to the population of a square mile, and those in charge of such buildings have long since found it necessary to so place their pumps as to enable them to draw all that the mains in their immediate vicinity can supply, regardless of the adjacent neighbor, who might get to wondering where the water had gone or was going to.

If a certain number of gallons of water per capita is essential to the health and comfort of a community, such can only be effective when properly distributed, and we can know when it is properly distributed only when we know that sufficient pressure is available at the various points to deliver the required quantity of water. First ascertain what is going on within the system, and the point at which any remedy is needed, and the manner of applying it will be suggested at once.

Of course you all realize the seriousness and importance of the fire service, and many of you no doubt can recall incidents and accidents wherein nobody exactly knew what did happen or how it happened. You only were aware that at some vital moment or other the water pressure failed. How far from the hydrant the failure extended you could not tell. The pumping station people declared that the pressure was all

right where they were, but even they had no evidence only their unsupported assertions. You have been making changes and extensions, and dwell in fancied security, when suddenly the call of danger comes and you find to your sorrow that some conditions existed of which you were not aware, which costs somebody many thousands of dollars, and after which you quietly apply such remedies as in your darkened state of information you conceive will meet the case.

In the larger cities where fire engines draw their supply from hydrants, many disputes have arisen as to whether there was or was not sufficient pressure to supply the steamers. It is possible to run a steam fire engine too fast to get any water to speak of, whereupon the charge is made at once that the mains were not under proper pressure at a certain time. A Pressure-Recording Gauge would establish the fact if the pressure existed in the main or not, and thereby teach the firemen that they must look out for their end of the combination or take the consequences. It is sometimes the fact that more steamers are drawing from the water mains in any certain locality than the capacity of such mains would justify, the result being that a less number of engines would do more real execution on the fire, for the simple reason that the same quantity of water would be delivered by fewer engines under a higher pressure than could be maintained by the greater number drawing simultaneously. This fact can only be arrived at by having records continuously made at different points throughout a system, it being evident that if a continuous record of pressure was kept, at some time or other, it would be made plain that the pressure was inadequate, calling attention to the fact in time to enable the application of a remedy long before the discrepancy had reached a dangerous point. This condition of over-draught of water in a given section is exactly what occurred in the recent Furman street fire in Brooklyn, and which resulted in a very much greater loss of property than would have occurred had the steamers been able to get all the water they required and could handle. What has since been done, viz.: the placing of an additional feeder to this section, might before have been done, and would have been had records been regularly made whenever a fire occurred in that vicinity, showing how easy it was to draw the head down below a safe and prudent point.

Upon one occasion coming to the writer's knowledge, where a part of the water supply was pumped by water power, and in case of fire the extra quantity was delivered by starting additional turbines, the fire department was somewhat tardy and the fire obtained such headway that a great amount of damage was done that should have been averted. An investigation of the facts proved by the chart from the recording gauge that the water increased in pressure immediately upon the fire alarm signal, notwithstanding that the fire companies all testified they were on hand within a few minutes and there was no pressure. The superintendent of the water works would have lost his position had he not been able to produce his record; and the multitude of witnesses who declared there was no pressure would have overcome the facts, the truth and the engineer's statement.

In a certain city politics interfered, as it sometimes will, with the efficiency of the water department, and it was determined to oust the superintendent, because he had been too active to suit the "outs." By pre-arrangement they filled the hose-pipes with stones and the flow of

water was so restricted that some of the citizens became alarmed in watching the headway the fire was making, and went to the pumping station only to find by the recording gauge that the pressure had been properly maintained without a moment's loss. This fact established, the "boys" took opportunity to clear out the hose-pipes one by one without being caught at it. Detectives subsequently arrived at the facts as above stated.

In another place a washout occurred during a rainy night and opened one of the joints on the force main where its embankment was exposed near a ravine. The pressure was reduced so much and so suddenly, that the low pressure electric alarm sounded, calling attention to the great loss of pressure and to the discovery of an enormous leak somewhere in the line. The superintendent was enabled to locate and remedy the accident before extensive damage had been done by the escaping water, to say nothing of the danger of fire and lack of water during the very much longer time that would probably have elapsed under other conditions.

Another example is of a gravity supply, which becoming inefficient, was supplemented by boring wells and supplying pumping machinery costing some twenty-five thousand dollars. Some time after completion one of the large manufacturers had occasion to overhaul a turbine wheel pit, and in so doing encountered what was considered a large and copious spring. After exploration and examination it was discovered that that spring could only be stopped when the 10-inch main delivering water to that section was shut off, and when this unexpected and previously unknown leak was repaired the new wells and machinery were not needed. Carefully noted record charts, in this case, consulted at regular intervals during the period of complaints which led to the investment of the twenty odd thousand dollars would most undoubtedly have developed facts that would have saved the unnecessary addition.

One of the most remarkable examples of the utility, value and practicability of pressure records is exhibited in St. Louis, where by their use the distributing system is shown to have been brought up to a perfection which leaves very little to be desired. The losses of head in different directions from the pumping station and reservoirs, considering the great extent of territory covered, are surprisingly small and uniform, indicating with perfect clearness that whatever the varying demands may be, whether in the manufacturing districts, where the demand is very large, or in the residence portion, where a comparatively thinly occupied area draws only what is needed for domestic use, the capacity of the distributing mains are properly proportioned to the work to be done. There is one recording gauge in the water commissioner's office, in the city hall, about three miles from the pumping station, and so perfect is the circulation, that the starting or stopping of any of the pumping engines is clearly marked. The days' history shown upon the chart is about as follows: Soon after five in the morning the gradual but slight fall of pressure from a horizontal line that has been maintained for several hours, indicates that the early risers are getting ready for breakfast; this fall goes on until about six, when an additional pumping engine is started to work, bringing the pressure back to normal or a little above. About six-thirty to seven, when the manufacturing concerns open up, the demands are clearly shown. Then the sprinklers taking water near

enough to the city hall to be felt, begin to draw water, and so the line goes on throughout the day, clearly giving the history of that day's consumption. Soon after six in the evening the gradual rise of pressure attests the fact that the day's work is over, that too much water is being pumped, and after this is allowed to go on so as to bring up the reservoir to a normal point, at ten or ten-thirty, the slight drop in the line plainly gives notice that one of the engines has been shut down; then the pressure line runs along through the night hours nearly or quite uniform. The stoppage of an engine in the night, either from intent, accident or carelessness, is plainly marked; also the time which elapsed before that or another engine was started again. Water Commissioner Holman has a habit of looking over the chart each day, and before the people at the pumping station understood how on earth the commissioner came to be so well posted, he occasionally astonished them by quietly dropping in and asking "the cause of the stoppage of a certain engine the night before."

A very interesting example of the value of record pressures was exhibited at St. Louis last fall, when one of the 36-inch mains burst about half a mile from the pumping station and two and a half miles from the city hall recording gauge. (See plate 3). It occurred about two-thirty Sunday afternoon, and no one would have known without a continuous record that there was no water hammer indicated just before the break, and its cause would have been enveloped in mystery a good deal deeper than it was, if the gauge had not shown with perfect accuracy that two or three reasons that a man in the dark would have given did not exist. The steady line usually shown on Sunday suddenly dropped nearly in a vertical direction, then continued upon the lower level for about half an hour, until the men at the pumping station, who had received the alarm, had arrived at the nearest shut-off gates and began to close off the broken section. Then the gradually rising line, indicating how long it took to shut off a 36-inch gate, was drawn by the faithful monitor, until normal conditions and pressure were recovered. That record places beyond dispute any and all claims as to time and duration of that break with reference to damage suits, quantity of water possible to have been discharged and other important items. Not the least part of the value of pressure records in this particular case, although an incidental one, was the high order of discipline and attention prevailing among the engineers in consequence of such a system at the pumping station, and which no doubt saved the city many thousands of dollars by reason of the prompt control of the large pumping engines suddenly relieved from pressure.

In a western city a neighbor of one of the water company's officers suffered a fire loss at his residence, and meeting said officer, complained that if there had been a little more water pressure the conflagration could have been extinguished at its early stage with the garden hose. The officer expostulated at the idea of the pressure not being sufficient to supply a garden hose, but when, a little later on, his own coachman complained, for the second time, that the water would not run in sufficient quantities to enable him to wash the carriages, our official friend attached a recording gauge at an appropriate point, and probably to his surprise and arlarm discovered that there were times during which the pressure fell to a point too low for the proper delivery of water at the points complained of.

Thus many instances could be introduced to exemplify the usefulness of such records, and in fact the gauge record is really the indicator card of the water works system, and no actual knowledge of any value to speak of can be obtained in either case without the appropriate instrument. Just imagine, if you can, where the refinements of steam engineering would have been to-day without the assistance of the indicator, then apply the reasoning to the other case, and draw your own conclusions.

It may be of interest to you to know that the recording gauge has been applied to the great oil pipe lines from the oil fields to the seaboard, where it is necessary to use heavy pressures, reaching as high as 1,100 pounds per square inch at the pumping stations. Bursts in the lines, with the attendant fires, were of frequent occurrence, but by the use and benefit of the pressure record, pointing out, as it did, abnormal conditions, sudden rises in pressure, caused by trouble with the pipes, and which would burst a pipe before any one noticed the rise for a few seconds only in the already heavy pressure, were prevented. Since the introduction of the recording gauge the troubles of abnormal pressures and breaks in the pipe lines have been entirely prevented.

There are now over a hundred gauges in operation on the oil pipe lines, and their total cost sinks into insignificance compared with the losses they have prevented.

A MEMBER: How many are in use in St. Louis?

MR. HAGUE: One at the City Hall, one at the pumping station and one or two that they move around. When anything happens they move them around to find out what the matter is.

MR. BRUSH: The Hackensack Water Company, with which I am connected, uses recording gauges. We have them at the pumping station, at the office, and also at the extreme end of the system—any difficulty alway being shown at the extreme end. The system is comparatively inexpensive and no one need tie himself to any particular form, as there are a dozen different forms. It is so readily applied that I do not consider any water works complete without it. I would not think of doing without a recording gauge system.

MR. HAGUE: I understand that Mr. Darling, of Pawtucket, has a recording gauge attached to each of his principal mains, so that a great draught of water caused by a fire, or any other reason, is indicated at once. At St. Louis the water is distributed with so little loss of head that there is not, I believe, two pounds wasted between the reservoir and the city hall.

Mr. Chase : We use the recording gauge as a means of telling whether the employes, when they go out to flush the mains, follow out their instructions; also as a means of showing whether the pressure is raised promptly on receipt of an alarm of fire and is maintained at the proper height.

Mr. Decker : I have with me some charts taken from a recording gauge, which will, I think, fully substantiate all that Mr. Hague has said as to their value, particularly when used in connection with the water mains. I will state in this connection that this gauge is placed about half a mile from the pumping station and 27 feet above the line of street mains.

Here is a chart showing the record of fire pressure. (See plate 9.) It shows precisely the time the pressure was raised, the amount of pressure carried (adding ten pounds for the elevation of the gauge), and the time it was maintained. You will notice a sudden sharp fall in the line of about 30 pounds. This was caused by the bursting of a line of hose. Also a corresponding rise or ram produced by the very quick closing of the hydrant. The series of vertical strokes shown during the day record were caused by the operation of a direct connected elevator. A reference to these charts will show just how many trips per day is made by the elevator. Here is another of interest (See plate 8), with an almost solid black line of about the width of a ten pound space on the chart, showing a constant and steady vibration of the water column. This vibration was caused by air being drawn into one of the pumps through a leaking gland on the piston rod; the leak was so slight that it escaped the notice of the engineer and was only discovered after I had observed the chart and gone to the pumping station to investigate.

The peculiar circumstances governing the location of our pumping engines caused the hot wells to be placed some three feet above the exhaust ports of the steam cylinders, which are of the Bulkley pattern—44 feet above. As a consequence the condensers are unable to lift over the condensation. This formerly collected in the exhaust pipes between the hot well and cylinders, giving considerable trouble. To obviate this difficulty I drain the exhaust pipes into a small tank, which fills in

from four to six hours, and is then pumped by the boiler feed pump into the boilers. The pumping of this tank reduces the vacuum from five to seven inches, causing the engine to slow up and a slight decrease in the pressure of the water column. This, you observe, is plainly indicated by the V-shaped drops in the recorded line. While this is more noticeable during the night, yet one may at any time determine just when this tank has been pumped.

I note these cases simply to show how sensitive is the action of the gauge and how important a factor it may be in the determination of difficulties, as well as its efficiency as a silent monitor of the fidelity of engineers.

J. H. HARLOW: We have a pressure gauge which shows the pressure of a sudden fire. This showing disarmed the opposition to us on one occasion when we were confronted by the claim of a lack of pressure. I would ask Mr. Hague whether, in gauge represented on the blackboard, there was not, in the extremes, some vibration of the up and down movement of his gauge records due to the momentum of pencil?

MR. HAGUE: The illustration given is a hypothetical gauge arrangement, but I think there might be at the extremes a little motion of the kind you suggest.

MR. ABBOTT: In 1887 I was superintendent of water works at South Bend, Ind. A fire broke out and there was no water. In this instance I happened to be at the works with one or two of the commissioners; the gauge showed a good pressure. I had the chart taken off and the signatures of those present put on it. Upon investigation the pipe was found to be filled with stones.

A. N. DENMAN: My experience with recording gauges commenced in 1883. In the first two months after our gauge was put on, we discovered that the engineer left his engine in the care of the fireman while taking a nap; that the fireman left his boiler in the charge of the engineer while he took a nap or went on an errand; that assistant engineers went home at night instead of attending to their duties, and depended on their wives to wake them up about the time they thought they ought to get around.

PLATE No. 1.

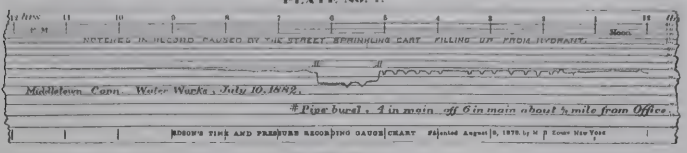

NOTCHES IN RECORD CAUSED BY THE STREET SPRINKLING CART FILLING UP FROM HYDRANT.
Middletown Conn. Water Works, July 10, 1882.
#Pipe burst. 4 in main off 6 in main about ½ mile from Office.
EDSON'S FIRE AND PRESSURE RECORDING GAUGE CHART Patented August 8, 1876, by M. B. Edson, New York

PLATE No. 2.

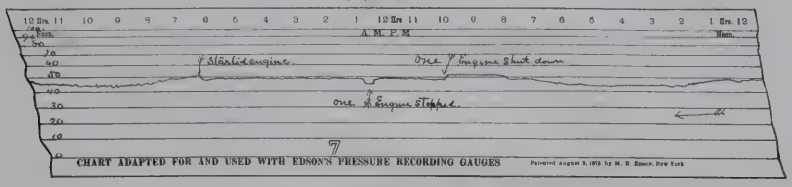

A. M. P. M
Noon.
Noon.
Starting engine.
One Engine Shut down
one Engine Stopped.
7
CHART ADAPTED FOR AND USED WITH EDSON'S PRESSURE RECORDING GAUGES
Patented August 8, 1876, by M. B. Edson, New York

PLATE No. 3.

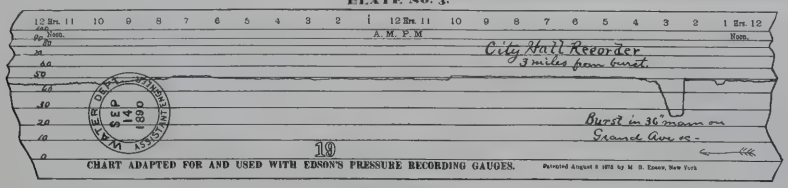

A. M. P. M
Noon.
Noon.
City Hall Recorder
3 miles from burst.
Burst in 36" main on
Grand Ave. #-
WATER DEPT. SEP 14 1890 NEWARK N.J.
10
CHART ADAPTED FOR AND USED WITH EDSON'S PRESSURE RECORDING GAUGES.
Patented August 8 1876 by M. B. Edson, New York

PLATE No. 4.

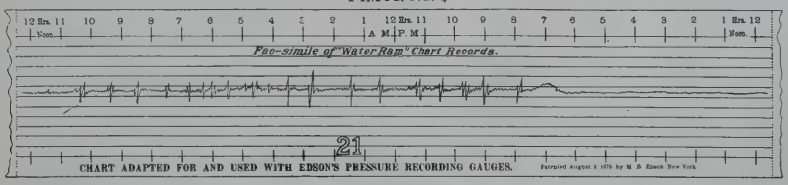

A. M. P. M
Noon.
Noon.
Fac-simile of "Water Ram" Chart Records.
21
CHART ADAPTED FOR AND USED WITH EDSON'S PRESSURE RECORDING GAUGES.
Patented August 8 1876 by M. B. Edson, New York

PLATE No. 5.

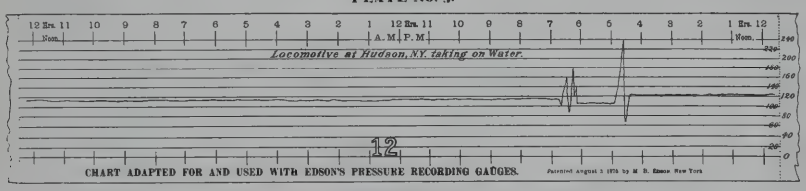

A. M. P. M
Noon.
Noon.
Locomotive at Hudson, N.Y. taking on Water.
12
CHART ADAPTED FOR AND USED WITH EDSON'S PRESSURE RECORDING GAUGES.
Patented August 8 1876 by M. B. Edson, New York

PLATE No. 6.

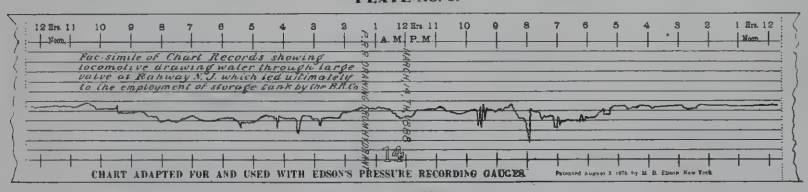

A. M. P. M
Noon.
Noon.
Fac-simile of Chart Records showing
locomotive drawing water through large
valve at Rahway N.J. which ed ultimately
to the complacment of storage tank by the R.R.Co
MARCH 14 1888
13
CHART ADAPTED FOR AND USED WITH EDSON'S PRESSURE RECORDING GAUGES.
Patented August 8 1876 by M. B. Edson New York

PLATE No. 7.

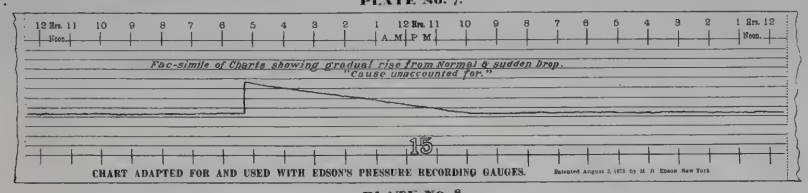

A. M. P. M
Noon.
Noon.
Fac-simile of Charts showing gradual rise from Normal & sudden Drop.
"Cause unaccounted for."
15
CHART ADAPTED FOR AND USED WITH EDSON'S PRESSURE RECORDING GAUGES.
Patented August 8, 1876 by M. B. Edson New York

PLATE No. 8.

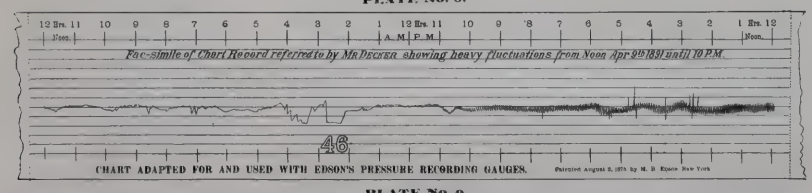
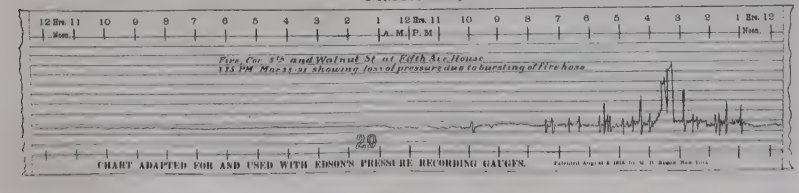

A. M. P. M
Noon.
Noon.
Fac-simile of Chart Record referred to by Mr DECKER showing heavy fluctuations from Noon Apr 9th 1891 until 10 P.M.
46
CHART ADAPTED FOR AND USED WITH EDSON'S PRESSURE RECORDING GAUGES.
Patented August 8, 1876 by M. B. Edson New York

PLATE No. 9.


A. M. P. M
Noon.
Noon.
Fire Cor 5th and Walnut St at Fifth Ave House
1.15 PM May 31-91 showing loss of pressure due to bursting of Fire hose
20
CHART ADAPTED FOR AND USED WITH EDSON'S PRESSURE RECORDING GAUGES.
Patented August 8 1876 by M. B. Edson New York

We have two recording gauges at our pump station, one for the steam and one for the water pressure. We used to have a vibration at the pump of twenty pounds. That is now reduced to five pounds. I think that in no case for months have we had a greater vibration at the pump than five pounds. About two years ago I put the gauge on at the water office in the city. While at the pump it is five pounds, the vibration of the machine at the water office varies from 20 to 100 pounds, demonstrating that the main at the water office is not large enough.

The recording gauge is an excellent thing. It will find out for you your leaks, detect the neglect of your employees, save you coal, and give you, if you study it, a vast amount of information which it is not possible, perhaps, to express here in off-hand remarks. I am for the recording gauge, and for a good many of them.

Two years ago, at Louisville, when we met there, I received a telegram from home stating that there had been a serious fire in the lower part of the city—in one of the newspaper offices, unfortunately—and that there was no water pressure. The newspapers said there was none, and as a fact there was none. Upon reaching home I found the council up in arms against the water company. I detached the recording card from the records, took it to the Mayor and said to him: "I wish you would exhibit that to your aldermen; it shows the pressure. If you want to test the accuracy of that gauge here or elsewhere, you can do so at our expense; but do not condemn us until you find out where the fault was." An investigation developed the fact that the firemen, either through negligence or design, did not open the fire-plug wide, and the fidelity of the officers of the works was fully proven. The Mayor finally returned the card to me with the statement that, in consultation with the legal authorities and also with the councils of the city, they had agreed that the water works company was not at all at fault. I can only repeat that I believe in pressure gauges and in many of them.

MR. CHASE: I have devised a little apparatus to attach to the electric fire alarm, which records on the recording gauge chart the time when the alarm comes in. If this is registered on the chart, and then the pressure

goes up immediately afterwards, an automatic record is created at once.

MR. DENMAN: Our charts are taken off at noon, when the names of the engineer and fireman on duty are marked on them, with the location of any fire that has occured. The chart itself shows the duration of the fire, or rather the time when the pressure was raised and its continuance. These records are found useful and are filed away.

THE PRESIDENT: I think the Convention is to be congratulated on the papers read this morning.

The next paper to be read in our regular order is one by Mr. Darling.

Mr. Darling is not present, I understand, being detained at home on account of the death of his mother and he has not furnished us with a copy of his paper so that it can be read in his absence.

We have just received a communication from Riehle Brothers, saying that a sample of their testing machine is on exhibition in one of the rooms of the hotel.

Gentlemen will you take up any other paper?

After adjournment, the Executive Committee will meet to discuss the question of the Committee appointed yesterday to consider the subject of Dr. Leed's paper.

Adjourned.

AFTERNOON SESSION 2:30 P. M.

The meeting was opened by the President, Wm. B. Bull, who said: The first business in order will be the reception of some applications for membership.

The Secretary then read the following applications for membership:

ACTIVE.

Phil Carlin, Supt. Water Works..... Sioux City, Ia.
C. F. McLain, Supt. Water Works,..... Syracuse, N. Y.
Chas. E. Bolling, Supt. Water Works..... Richmond, Va.

FOR ASSOCIATE MEMBERSHIP.

Samuel L. Morison, Pres. Morison Allen Co.....New York, N. Y.
Holyoke Hydrant and Iron Works.....Holyoke, Mass.

It was moved and seconded that the rules be suspended and the Secretary directed to cast the vote of the Association for the candidates named.

Carried.

THE PRESIDENT: The next order of business is the reading of a paper by Mr. B. F. Jones; Mr. Jones is not present, but the Secretary has his paper and will read it.

HYDRAULIC ELEVATORS.

Objections to Their Use by Water Works, and Advantages to the Public by Their Use.

B. F. JONES.

In 1883 at Buffalo, and 1884 at Cincinnati, I had the pleasure of reading papers upon the subject of Hydraulic Elevators, Motors, &c., which seems to be almost inexhaustible.

In 1884 the Company which I represent had about fifteen passenger and eighty freight elevators. At this time there are forty-three passenger and one hundred and twenty-one freight direct pressure, and sixty-five tank elevators, in all 229.

The objection to their use by companies using the direct pressure system is mainly due to the fact that they require large openings at the main in order that the service may be satisfactory. Large openings in the main are objectionable for various reasons, among them,

1st. In case of a conflagration destroying the building the inlet pipes are likely to be destroyed by the falling building, thus making possible a large useless waste of water in the cellar, equal to several fire streams, and a corresponding loss of pressure which must be made up by the pumps at the other end of the system which may not at all times be equal to the duty required. A wall falling outward would cover the stop-box, making it impossible to shut off the elevator supply at a critical time. Therefore it is easy to understand that if several elevators were thus destroyed and their destruction prevented adequate pressure, the damage coincident would be far in excess of any benefits to be derived from the sale of water for power purposes.

2d. Another objection is that where water is delivered through large openings like those connecting direct pressure elevators, the sudden opening and closing of the valves is injurious to the pumps, causing that mysterious "water hammer" to perform its deadly work.

It is therefore a grave question whether the revenues obtained from this class of service are compensating for the risks continually carried: and yet, in an experience of sixteen years, I can recall but one instance in which the breaking of elevator connections had any appreciable effect upon the pressure.

However, in view of our difficult service, and obligations to the city in respect to fire protection, we have ceased to make any more connections for direct pressure elevators. This course gave much dissatisfaction to a class of persons occupying small stores who could not afford to operate steam elevators or those supplied from tanks. In many instances the buildings would not sustain the weight of a tank, nor would the rentals justify the owners in making them strong enough ; nor could the occupant, probably, stand the expense of operating a tank elevator by steam power, and so it turned out that the occupants of such small stores had to resort to the old hand elevator or walk up and down the steps.

Another objection which may be mentioned in this connection is that the inlets to these elevators are so large that neither the Water Company nor the occupant can afford to furnish the large, expensive meter required, and without meters reliance cannot be placed upon the quantity used. The ordinary indicator gives the number of feet traveled by the piston, and every foot traveled indicates a given quantity of water, according to the size of the piston, but as the packing becomes worn there is a constant leak and all the waste is a loss to the Water Company.

For some years, up to the first of the year 1890, our Company furnished water for power purposes at a less rate than for other consumption, and in consideration of this we demanded all elevators to be supplied with meters, but a revision of the rates on Jannary 1st, 1890, made no such distinction, and therefore we had, under our rules, to either make a rate or furnish a meter. We now do neither. We simply do not furnish water for new or additional direct pressure elevators.

The benefits or advantages to the public have already been somewhat outlined in the preceding, and there seems to be little else to say. If, for example, a small merchant or manufacturer has little use for an elevator the expense is a mere nominal matter, much cheaper than the same service could be performed by hand in many instances, and this will apply to large establishments to a point where the charges for water would not exceed the wages of a man, say $30 or $40 per month. To this class of establishments the advantages are decided.

To larger establishments where the rates run up to $75 or $100 or more per month, and the facilities for steam already at hand, it is an even swap to pay for engineer and fuel to pump the water over and over to a tank as against paying for water to save these expenses. In our experience these liberal consumers of water do not appreciate the advantages of it in saving expenditures in other directions as indicated. In office buildings, especially when times are dull and tenants scarce, they regard it a hardship to pay water rates almost, if not quite, equal to flush times and premises full of tenants, never considering that it takes as much water for an empty elevator as for a full load.

Another important advantage is in its cleanliness, especially in summer, as compared with the heat and smoke of the furnace, not to speak of the insurance risk being lessened by reason thereof.

All things considered, it strikes me that the tank system is the most desirable for a water company, and the direct pressure, in small establishments, the most desirable for the consumer. In large hotels and the like, the superiority of either is immaterial.

Further deponent sayeth not.

THE PRESIDENT: It is always agreeable to us to have a reminder from Brother Jones, even if he cannot be here in person. The subject is now open for discussion.

MR. BENZENBERG: There is another point that has not been touched upon by the writer of this paper, and that is the decrease of the working pressure caused by several elevators taking their supply from the main at one and the same time. We have had a number of such instances at Milwaukee, where we have some six hundred elevators directly connected with the mains, where the draught of water caused by operating the elevators at the same time, would so seriously interfere with the pressure as to prevent the use of the elevators above the second story. In a tank supply, the pressure is uniform for the elevator which is supplied from that tank and independent of any other source. It has the full service of the pressure given by the tank at whatever elevation it may be placed and can render a much more efficient and rapid service. Whereas, service derived from the street mains is not always satisfactory, because it is a slow service and depends very largely upon the use of the elevators in the neighborhood. We have had instances where in one block it happened so that four elevators in adjoining stores were started at the same instant and when they got up between the second and third story they failed to ascend further, and upon investigating the matter it was found that one elevator was drawing water away from the other, notwithstanding that the main in the street was a large one—had been enlarged in order to somewhat overcome the losses of pressure. That has been so great a grievance with our people that they are beginning to favor tanks for elevators, whereby they may have a pressure that is not subject to the influence of water drawn from the mains by their neighbors, and which fact I think will favor the use of tanks for elevators over the direct supply.

MR. DECKER: Mr. President, this is a topic of my suggestion, but the major has failed to follow the line I had expected. It should have been on the injurious effects of direct connected elevators upon the mains, services, machinery, etc., and it is upon this line that I would wish to open the discussion. I have never fully

approved of a direct connected elevator, but have not been able to get any tangible evidence of the actual effect produced upon the mains by their use until recently. I have on one of my works a freight elevator in a wholesale grocery house, which is connected by a six inch pipe to an eight inch main; to this main I connected a recording pressure gauge which is placed in my office, the office being upon the second floor, the gauge is 27 feet above the line of the street main and 32 feet above the elevator cylinder, and is 2,200 feet distant therefrom. I have a number of charts here taken from this gauge and a reference to them will show that the opening of the valve, in some instances, causes a sudden drop of pressure of 10 to 15 pounds below the normal, and the closing of it a rise just as sudden and sharp, of 55 to 60 pounds above, making a total variation in pressure of some 75 pounds, and even this is sometimes greatly exceeded. This variation is not, however, arbitrary, but is governed largely by the load on the elevator and the height travelled. With a light load, or in traveling but one or two stories, the valve is rarely opened so wide or so quickly, as a consequence the vibration in column is not nearly so great. This same action is shown upon our pumping engines, which are nearly a mile distant from the the elevator,—we pump direct—the opening of the valve will cause the engine to start up and run quite rapidly for two or three revolutions, while the closing of it quickly will often bring the engine to a dead stop. Now, while in this particular case the effect may be extreme, somewhat exaggerated, owing to the smallness of the main for so large a connection, yet there is undisputed evidence that the operation of these elevators does cause "ram." I presume as brother Lineen is not present I may be allowed to designate it as such, and not be compelled to call it a "myth" or some other animal, (laughter) and it stands to intelligent reason that these sudden blows, of, say, from 60 to 75 pounds per square inch force, upon the mains and the various appliances, such as meters, water closet valves, etc., attached thereto, must be injurious to their life and service. As I am fully aware that many of my brother members here have had large experience in this line, I will be much pleased to have them follow the discussion in this direction, knowing

that I will be much benefited thereby and believing that there are many others here as deeply interested in the subject as myself.

MR. WAGNER: I was glad indeed when I noticed on the program that the subject of hydraulic elevators, and objection to their use by water works, was to be discussed. This is a matter in which I am deeply interested, and with the hope of gaining some useful information on this subject I have attended this convention for the first time, which I have enjoyed very much. Like Mr. Decker, I have also small works to which are two passenger and six freight elevators, directly connected with street mains; one of these (the passenger elevator in a hotel), has a six inch connection to an eight inch street main; from the six inch service are taken four stand pipes for fire protection, then it is reduced to a four inch pipe running to the elevator. When the elevator was ready for connection I objected to the large opening. I first noticed the water hammer at the pumps. In the first four weeks the elevator was connected with the mains all the dead ends within four thousand feet of the elevator were blown out. The water hammer from the elevator would pass the stand pipe and stop the engine (a beam engine) running at sixty feet piston speed per minute. I hope that some member of the Association present can throw some light on the subject and suggest a way in which I can form a cushion to stop the concussion on the entire system.

MR. FISH: I think the matter is perfectly feasible. The first thing is to take a connection from the main into a large air vessel—it may be very large and long. Take the water from that to the elevator and it will be found that the ram will expand itself in this air chamber and you will get a higher pressure of water at the elevator.

MR. WAGNER: I would say in connection with that line of thought that my stand pipe is between the pumps and elevator, and that when the concussion came to the stand pipe, the stand pipe would act as a relief. The freight elevators give me no trouble as I can control their flow by the valve at the curb; they, of couse, run slow and the consumers are satisfied.

Mr. Gardner : Mr. President, this discussion promisesto give me information for which I have searched in vain. It is how to prevent water hammer or hydraulic ram caused by the operation of elevators managed by direct pressure. It has been said that a large air chamber will counteract the influence. If I understand the suggestion I can say I have tried it by running a four inch pipe up through the building and several feet above the roof; and while the device may have ameliorated the condition, the vibration or hammer still continued.

Mr. Bolling : Our system in Richmond is the reservoir system. We have a direct connected elevator, six inch pipe, 4 inch connection, pressure 45 pounds. The ram was seven pounds every time that the elevator was used. I insisted upon putting in an air vessel and since that time we have had no further trouble.

Mr. Chase: Mr. President, I would say that we have the same arrangement Mr. Wagner has mentioned. We have a 5 story elevator and when it is used the pressure will fall about 30%, or 10 pounds, and on closing the valve the pressure will rise about 20 pounds. We attempted to remedy it with an air chamber, putting on an 8-inch pipe as near the valve as we could get it. When it has been newly charged it is quite satisfactory, but in the course of a month or so it loses its efficiency. I have contemplated adding to the elevator some automatic quick acting device that would keep the chamber charged with air; I believe that if we kept it about half full of air at the corresponding tension there would be no trouble with the ram, and to a certain extent we would get rid of the sudden fall of pressure on using the elevator.

The Secretary : I think the great trouble in the cases mentioned by Messrs Decker and Wagner and some of the others is that the works are not large enough for elevator service; they were not designed to furnish hydraulic power. Certainly a 6 inch opening, with a quick operating valve, is too large to allow on an eight inch main. And this brings us to the question, whether it is good policy to build water works for supplying power; whether the revenue received from power furnished gives an adequate return for the additional expense in-

curred in constructing and operating a works designed for furnishing power over a works designed for domestic use and fire protection only. The amount of water to be provided and pumped is not the only consideration; we must have much larger mains to give the large supply required for elevators and motors without reducing the pressure too much. It frequently happens that where a small supply of excellent water can be obtained; a large increase in the amount required necessitates using water of an inferior quality; in such cases it would seem that furnishing water for power was certainly a mistake.

MR. WAGNER: I was forced to give a six inch connection on an eight inch main; it was not my own suggestion or choice.

MR. MILNE: The air vessels are not always practicable to offset the cushioning influence of the water ram, for the very reason stated by several gentlemen on the floor; because every stroke of the water hammer gives an insensible diminishing power to the air vessels. That is, the air leaks out. Now to compensate for that it is simply necessary to have the application of machinery for an air pump, and that it should be regular so as to keep up a constant supply of air to compensate for the escaping air from the air vessel. That is another element which makes an added difficulty. The plan suggested by Col. Jones is to my mind a better plan—the tank system. There you have a constant factor or pressure. Where there is an extended system of using water for hydraulic power it would be apparent in that there is a very simple illustration of it. For instance, one gentlemen says that he gave a six inch connection with an eight inch pipe, and another four inch.

MR. WAGNER: They had a fire connection from the six inch pipe and a four inch connection from the six inch pipe to supply the elevator.

MR. MILNE: I don't think there is any engineer here ever understood the principals of such a branch supply of hydraulic power, and it seems to me unreasonable to contemplate that for a moment as being of any practical importance. All practical men, as we are, are

in search of information and we get it by experience, which is sometimes very disastrous. Now I would advise the abandonment of the direct pressure for an elevator system, unless you have a very large surplus of power or energy in your static head of water; unless you have that I should insist upon a tank. The difficulty with the tank is that you only have a static head depending upon a stated quantity of water. You have got to devise means to fill your tank for any draught. There are times when your elevator needs to use a requisite amount of water to compensate with that. I think the time will come, if we live long enough, when we can begin using water as a hydraulic power, but at this time I think it is perfectly ridiculous for us to entertain this thing for a moment as being able to supply water as a hydraulic power, and at the same time maintain a system of distribution.

Mr. Edson: It may be proper to add a little to what has been said on this subject, but before doing so, would say that it appears to me that water works are generally introduced, first, for sanitary purposes, and secondly, for fire protection. Possibly, the latter may take precedence. In neither of these cases is the cost of water to be seriously considered, owing to its obvious importance. If, on the other hand, the water can be supplied so cheaply that its cost is not considered, irrespective of the important mission it is intended to perform, then, it is simply a question of increasing its quantity and provisions for its distribution, in order to remove both the "head" and "water-hammer" troubles, but if it is so valuable that it cannot be supplied cheaply, and it is supplied through meters, I doubt if there would be much of it used for elevator purposes. Certainly, it would be employed carefully and frugally if paid for under meter rates. In other words, where water is scarce and expensive to obtain, or convey, its use should be restricted, primarily, for the first two purposes as named, viz:—sanitary and fire requirements, and not subordinate to the vicissitudes incidental to its employment for mechanical purposes.

In the matter of the difficulty of maintaining air as a cushion in the reservoir, or dome to pumps and other

mechanisms, and preventing its fugitiveness, which has caused so much trouble, I would like to call attention to the fundamental principle governing its employment in this manner, because I think it would suggest a remedy. If we remember that air is held in invisible suspension in water, according to the pressure the water is under, and that if we decrease this pressure we decrease the amount of air which can in this manner be held, we have a key to the whole subject. That is to say, when water is under great compression it will hold in invisible suspension more air than capable of when liberated of its pressure. Now, its application in this case appears to be as follows: When we are pumping water from natural sources, say a river, the water is introduced under atmospheric pressure, depending upon the location of the pump inlet. Shortly afterward it is imprisoned and placed under pressure, owing to which its capacity for air is increased, with a result of a depletion of that contained in the air dome. Many have thought this air from the air dome was mechanically entrapped until they had so contracted the lower orifice as to make such impossible, when they learned that some other solution was required. This body of water, under increased compression, eventually escapes at the various outlets, and in doing so reduces the amount of pressure on the mains in such vicinity. This reduction of pressure enables the escape of excessive air previously held in the water, and so accounts for the surprising amount of air in its isolated form, which we frequently find issuing forth with the water, but separated from it, and which we know could not possibly have entered at the suction in its individual or isolated form. Whatever water or air escapes from a water system must have been introduced at its suction. It follows, therefore, that if air is present at the discharge points it must have entered in some form at the suction. If, then, we find it causing "water-hammer" in the mains and spurting at the outlets, in its individual form, it must have been taken in at the suction, either in that form or impregnated mechanically with the water, and for some reason afterward *separated therefrom* in the process of conveying the water under compression, and I think the idea advanced is worthy of consideration in this connection, because it will enable us to

provide air when we place water under pressure, and will remind us of the necessity for providing air outlets at high points where the pressure is reduced. It seems to me to be nicely illustrated by reference to the atmosphere, a cubic foot of which in this room contains to-day so many grains of water in invisible suspension. If the atmospheric pressure increase or we compress this given quantity of air to one-half its previous volume, we precipitate one-half its moisture (which before was invisible) in the form of water.

I have compressed it to the extent of 30 temperatures, and by carrying off the water and separating it from the air, which formerly held it in invisible suspension, have then re-heated and re-expanded this air to its normal condition of volume in the presence of wet pulp or gun cotton, with the result of quickly drying the water out of such pulp to a degree of dryness not possible in even a hot drying-room, and without raising the temperature of the pulp or air brought in contact with it much above the freezing point. This subject of the combination of air and water, varying in quantity with temperature and pressure, must be understood in dealing with the subject of "water-hammer" and air reservoirs or similar expedients for its remedy.

In one water plant it has been found necessary to pump air into the discharge from the pump with perfect regularity, in order to work the system at all, and I presume there are many cases where this is either done, or could be, to advantage.

Under the subject of injurious and annoying concussions, which have been referred to as the result of quick working valves, "water-hammer," pound, etc., I would like to describe a device once employed with much success. The discharge from a single acting pump, working under considerable pressure, became annoying throughout the building, and as air domes did not meet the case, I removed a portion of the discharge pipe, say 24 inches, and substituted rubber hose, clamping it over the exposed ends of the pipe which had been severed. Then, for safety, enveloped this with a pipe a few inches larger in diameter, by using flanges, so that the interior space between this outside jacket pipe and the rubber was, say 1 inch all round. The substitution of rubber

prevented the transmission of sound, forming an elastic cushion, yielding with every seating of the foot valves, and the jacket at the outside removed the danger from water, which might occur if the rubber hose gave out. By arranging a pass around to this contrivance, provided with two valves, it becomes an easy matter to substitute new rubber when occasion requires. This expedient provides a very simple and practical way of removing the annoying pound, so often heard in large buildings, hotels, etc., caused by improper working of pumps, and particularly those called single-acting, while the reduced wear upon the various valves and fittings is at the same time removed.

Mr. Denman: Mr. Chairman, I believe in furnishing water to water elevators, not only as a matter of profit but also as a sanitary measure. The building that is furnished with water for an elevator is free from the dust and dirt of the coal and from grease necessary to keep the steam engine and other machinery in good order, and will be saved from much expense, besides tending very largely to the comfort and cleanliness of the whole concern. As a matter of profit there is nothing that will pay better, providing that we are adapted to it. It is preposterous to suppose that you can furnish a six-inch attachment to an eight-inch pipe, thus giving to one elevator nearly half of the entire capacity of your pipe. It is not only not strange that there is a water hammer there, it is simply wonderful that the pipe is not kicked out of the ground. We have in Des Moines between thirty and forty elevators. I remarked this morning that the presence of the gauge indicated that there was a certain part of our city that needed larger mains; that whilst the vibration at the pump was but five pounds, the vibration at the office in the lower part of the city ranged from 20 to 60.

One reason why we need large mains is because we are furnishing elevators, and we intend to furnish elevators so long as a single elevator will pay as much as many private services and add so materially to the revenue of the company. We have lately reinforced our system in the lower part of the town by putting in a twelve-inch pipe, for the purpose not only of bettering

the fire service but also of incidentally reinforcing the elevator service.

That there are devices by which the pressure on the mains can be regulated is true, but that they can be maintained in their integrity from year to year and through every decade without attention or repairs, is not true. You do not expect that in regard to any other part of your machinery. You must attend to that matter on occasion.

As to the air chamber I avow my belief that they are a perfect cure for water hammer if properly arranged.

I felt like interrupting brother Gardner to ask him whether when he run that pipe up ten feet above the roof he was sure he had an air chamber.

MR. GARDNER: The plumber did the work so you cannot tell. (Laughter.)

MR. DENMAN: I thought so. Your pressure can be shut off and the air chamber charged but, of course, the chamber should bear the proper relation to the size of the pipe. You cannot supply an elevator with a four to six inch pipe and put a four to six inch air chamber; that will not do. Make your air chamber as large as you conveniently can. Let it have all the air you can conveniently give it. Then keep watch of it. You will thus maintain a perfect air chamber, and have no trouble from water hammer. We have never in our experience had but one burst from the water ram, and that was clearly demonstrated to be the fault of the air chamber. Two meters which cost $140 were ruined in one month. We declined furnishing any more meters until the gentleman got his air chamber in good order. He put in a new air chamber; it was put in by a plumber. Upon examination by merely tapping it with a knife, it was found to be deficient as an air chamber, but he said it was a proper air chamber, and that the man who put it in knew as much as we knew about it. Well, we said run your elevator without a meter, but he had not run it more than three or four days before away went the packing. Now, says he, you put on your air chamber and I will pay for it. We put in our air chamber and the meter, and he paid for them both, and so far the

elevator has been running with no accident. The pipe is about three inches and the air chamber is about six inches.

A MEMBER: How long is your air chamber?

MR. DENMAN: About 15 feet long; although I never measured it, I should judge it was that length.

A MEMBER: Don't you think an air chamber three feet in diameter and 10 feet high would be better.

MR. DENMAN: I presume so and yet it is so far in excess of any need that it has never been thought of. Eternal watchfulness is said to be the price of liberty, and in some ways it is the price of safety in an elevator service.

MR. CHASE: I suspect our friend's air chamber was so high above the building that he could not see whether it was capped at the top and perhaps he got it above the top the water supply. I am in thorough accord as to the of sale of water. I am willing to sell water to anybody who wants to pay for it. In the line of what Mr. Milne has said about the tank question, I would say that it seems to resolve itself into a question whether the consumer wants to pay a higher rate for the water. If the reservoir is 100 feet above the elevator, and he puts in a tank of only 50 feet elevation, he would practically use twice as much water and would have to pay twice as much money. Whether the consumer could stand the expense or not depends upon the local company's rates. I suppose it is pretty generally the case everywhere that we put on all the traffic will bear any way.

MR. MILNE: I was going to say that the variation from the general plan of distribution of water originally designed for hydraulic purpose is certainly an inovation. I do not blame the water superintendent for trying to make all the money he can out of his plant, but you must have consideration for mechanical and engineering construction. It is not a new thing in Europe and if you will refer back to English works of standard reputation you will find that the experience of many of the water works in the prominent cities of Europe are pretty much the same as you are now passing through and

what is the result to-day. In the city of Liverpool there is a hydraulic power company organized and taking water nine miles from Liverpool under 350 pounds pressure devoted exclusively to hydraulic power. Now that is the result of experience. What is the result to-day? On the seven miles of docks in Liverpool there is not now a puff of steam to be found. It is all hydraulic power, employed for hoisting goods in the warehouses and for warping the Cunarders in their dock. It is done by hydraulic instrument. This subject justifies your deep consideration. Of course your location of towns differ largely. In western cities where elevator power becomes inevitable to develop commerce, that consideration will force itself upon you, and my advice is to make your works for hydraulic power entirely independent of your present plant for distribution.

Mr. Benzenberg: I can see good sound logic and reasoning in the statement that we are ready to supply any number of elevators with water as long as they are willing to pay for it. This will do while your works are fully equal to meet any possible emergency with a good safe margin in addition, but when your consumption has increased and your district has become well populated and the elevators connected direct with the main have reached that number when it will become necessary either to detach them and to force the owner to use the same water over and over again by putting in a tank on the top of the building or to relaying the mains through the entire business district, then I think that you have reached a point where it will strike the superintendent or president or operator of the water works entirely different. It means an outlay without a necessary increase of the income. The revenue will be the same, but the cost of laying additional mains or of digging up the old mains and laying larger ones must be met, and that is not a very small item of expense and it is coming, is sure to come up in your business sections where elevators are being used. It is going to rip up all the paved streets in the very heart of your business sections. It possibly will distrub for the time being the service of the connections of all the consumers along the square in which you are laying mains; it means a great deal of annoyance to the company and dissatisfaction on the

part of the consumers as well. It seems to me there should be some rule, on the part of the water department, limiting the size of the opening in the main and limiting the number of connections to the main in a square. We have in Milwaukee reached that point where we are obliged to refuse any further elevator connections in certain sections of the city. Half a dozen on one side of the street have taken elevator connections varying from three to four inches in diameter, with perhaps a smaller number on the opposite side which, if running anywhere nearly at the same time exhausts the supply of the main, to say nothing of the interference with the amount of water that the main may be required to furnish to the distribution beyond that point. We have on one or two occasions when asked by the consumers, taken up the main and replaced it with a larger main but that is only temporary relief, and in the course of a few years we shall be in identically the same position that we were in a few years ago. We have had no trouble with the water ram. We have got, as I said before, some 600 elevators supplied directly from the main in the city and we have not anywhere had any trouble with the water ram on account of the opening or closing of the valves. We have had no complaint from consumers in the neighborhood of elevators nor in any districts where a great many of these elevators are being used; but I attribute it to this fact, that there are so many elevator connections in the district that the opening or closing of one elevator connection or valve is always met by a reverse action on the part of some other elevator and the hammer caused by the closing of a valve is compensated for by either relieving or taking it up in the opening of some other valves. We have not put in any air chambers or any other device to take up the water hammer, for the reason that we have had no occasion for it. I confess I have been very much surprised at the complaints in regard to the water hammer caused by hydraulic elevators, especially to such an extent as has been made this afternoon.

Q. What water pressure do you carry ?

A. We carry in the business districts from 50 to 55 pounds in the main.

Q. What is the limit of supply pipe to the elevator?

A. Four inches.

MR. HOLDEN: I would like to inquire as to what meter you use?

MR. BENZENBERG: We do not meter them; we put in an indicator, a device of our own, which we have found to work very satisfactorily. Of course the income depends largely upon the extent that the elevator is run. It varies from about $125, the least, up to $800 a year. I think that is as high as we get. Of course our meter rates, I would say in this connection, are not very high. They are according to the following rule: Every consumer of water who has a meter pays for the first 25,000 cubic feet at the rate of $.20 per thousand gallons of water—whether he be a large or small consumer. They all pay for the first 25,000 feet at the rate of $.20 and for the next 25,000 they pay at the rate of $.13 per 1,000 gallons and at the rate of $.08 for the next 50,000 cubic feet which brings it up to 100,000 cubic feet and all above 100,000 up to 500,000 is paid for at the rate of about $.05⅓ per 1,000 gallons. All above 500,000 cubic feet to be paid for at the rate of $.04⅔ per 1,000 gallons, and of course in comparing the income for our elevators you have to take these rates into consideration, there being a difference in the meter rates.

MR. RIDER: I would like to ask Mr. Benzenberg if he starts with the same figure every year in regard to the rates?

MR. BENZENBERG: Yes, sir; this rate is figured from the first of January each year.

MR. HAWS: I agree with the statement that has been made. If you put in a small works you will not have what you want. Now this convention represents the whole United States, and they are just the ones to expand their ideas, and they want to expand them in proportion to the territory they represent. You want to start with bigger ideas than you have started with; you all have to get your water works in at the least expense, and that is not always the best policy; this has sometimes been the case with steam engines; a man puts in

the smallest engine he can get to do the work with, so that he can save a few dollars, and then he undertakes to do all the work he can do with his boiler, and he raises all the steam that he can carry; everything is figured down to the lowest notch, and bye-and-bye as his work increases he finds that he lacks power, and that is the same principle that has been followed in the erection of water works; the error has been at the fountain head, at the starting point. Now get your ideas up. If you think you will want 200,000 gallons per day put in a works with a capacity of 1,000,000 gallons per day; get your ideas up in this way on your pipe, and put in larger pipe, put them in large enough and then you can afford to take a six inch supply off your main, but not off an eight inch main. You go in and you form an estimate of the population, and of how much water is to be used per capita in such a place. Some contractor may come along and tell you that a certain amount is all that will be wanted, because he is desirous of getting the contract cheap. What you want to do is always to double it if not triple it, and then go ahead, and you will get something for a future supply as you grow and increase; but if you keep your ideas down and provide only for what you think you will want you will always fall short.

Mr. Benzenberg: Your ideas will always be big enough if you have a large enough pocketbook. I don't think the engineer will contract his ideas except as the purse is closed down upon him.

The Secretary: I suggest that Mr. Benzenberg and Mr. Denman take this matter as a subject for a paper next year and give us their views of it, as they seem to be about as nearly opposite as can be.

Mr. Richards: If he is going to write that paper I suggest that he tells us how he is going to run fifteen elevators out of a six inch pipe all working from the same pipe. (Laughter.)

The Chairman: We have had a good discussion on this paper—the first really good old-fashioned discussion that we have had since we began this session, and I want you to take notice it all sprang from what Brother Wagner, one of our new members from Georgia, said.

It only shows that we ought to give encouragement to every new member, whether a confederate or not, who asks for information if he feels he needs it.

MR. WAGNER: I would say while I am from Georgia, I want to correct you on the term confederate, I am not a Georgian, I was born in Buffalo, New York.

MR. RICHARDS: You are perfectly welcomed to live in the south.

MR. WAGNER: I am a Georgian by preference.

THE PRESIDENT: I saw you in a confederate crowd taking your luncheon, and I think a man is known by the company he keeps.

MR. PAGE: Mr. President, I am down in a confederate town too, and am very much in the same boat. We have one elevator supplied by two three inch taps, from a ten inch main, running into a five inch pipe, as we would not allow a five inch hole to be cut in the main. We have had similar difficulties as mentioned by the gentleman from Georgia. But since listening to the gentleman who has forty elevators on a six inch main without experiencing any trouble, I have decided it is like the old story of Alexander The Great, where one single elevator would be very harmful, if we should put in forty more we would be great, and not get "Ramed" like we did before; and it makes no difference how small your main is. (Laughter.)

THE PRESIDENT: If there is no more discussion on this paper we will pass to the next paper by Mr. Rider.

THE NECESSITY OF MORE ACCURATE KNOWLEDGE OF THE FLOW OF WATER THROUGH PIPES, AND SOME EXPERIMENTS WITH THE "WATER HAMMER."

BY JOSEPH B. RIDER, C. E.

In view of the fact that over 30,000 miles of water mains have been laid in the United States alone, a paper on the necessity of more accurate knowledge of the flow of water through pipes, may seem out of place, but when we remember that formulæ for the flow of water are about as numerous as our water systems, one cannot wonder at the variations in the estimated capacities of main lines or other conduits, as given by different engineers. The trouble is not so much with any certain form-

ula, but in its application in connection with conditions which are entirely different from those of the experiments on which the formula was founded. Because of this variation in results, the public is apt to lose confidence in an engineer's ability. I know that when called upon to give an opinion, we try to approach the truth as near as possible, and if we were asked to calculate the capacity of a conduit, each, by the aid of his own method or favorite formula, would give the result, but few of us would like to say that our own result is within 15%, unless perchance, the conditions of the problem were nearly identical with those of the experiment on which the method or formula used was based.

With all due respect to professor, engineer, village official and citizen, I must relate a few instances where opinions upon the subject in question have been at variance.

A few years ago we were called upon to prepare plans and specifications, etc., for a $100,000 system of gravity water works. This was done, but the plan met with a bitter opposition from a college professor, who claimed that on account of the great loss of head due to friction in the five miles main conduit, and the numerous street branches, etc., that the water would *hardly* pour from the hydrants.

In due time, however, the works were constructed, and we had no difficulty in throwing a good stream through 150 feet of hose over his residence, which was at least 75 feet distant.

In a case I recall to mind, the capacity of a main conduit was variously estimated by different parties from 900,000 to 1,200,000 gallons per twenty-four hours. The actual capacity was found to be a little over 800,000 gallons.

Recently I became engaged in a controversy in regard to the discharge of a 24-inch pipe (not under pressure). My opponent claimed that the conduit would discharge just as much when the outlet end was submerged to the top of the pipe, as when discharging with a free outlet.

The results obtained from a series of forty experiments, compel me to still retain the belief that the capacity of a conduit, with a free outlet, is greater than that of the same conduit with a submerged outlet, except in a case where the stream into which the pipe discharges moves with a velocity equal to, or greater, than the velocity in the pipe.

While waiting to address a village Board, not long since, I chanced to hear a heated discussion, which was quite amusing.

A Mr. B had made complaint to the Board of excessive water tax. It seems his factory was supplied by means of a 2-inch pipe connection, and the Board charged him $100 per annum for the privilege. His neighbor, Mr. A, was supplied by means of a 1-inch pipe connection and was charged $50 per annum. Mr. B was under the impression that on account of the greater surface there was greater resistance to flow, and that a 2-inch pipe, though twice as large, could not deliver twice the water. The Board seemed to think that his objection was not of sufficient weight to justify a reduction, and voted that Mr. B's tax remain twice that of Mr. A.

An instance like the above can be excused, for none of the parties concerned were scientific men, and probably considered that inasmuch as a two-foot rule is twice as much rule as a one-foot rule, a two-inch pipe must be twice as much pipe as a one-inch pipe. But at this late day,

when the public depend upon us to impart to them our knowledge, it certainly is humiliating to have such a variance of opinion among us.

Last week I made an experiment on a 16-inch cast-iron conduit. The results are here introduced, not so much on account of their interest, as to show a comparison of actual with calculated capacity.

The section of 16-inch cast-iron pipe (all below hydraulic grade) used, was 7,350 feet long; eighteen feet from the upper end, a 12-inch line is connected with the same 16-inch line, and runs toward the city.

The 16-inch line has a fall of 48.7 feet in 7,350. The 12-inch line has a fall of 28 feet in 7,350 feet.

When the 12-inch gate, which is situated just below the connection, was opened, the 16-inch (discharging with full outlet) was found to discharge seven inches deep over a well constructed weir three feet wide. When the 12-inch gate was closed, and all water passed through the 16-inch, the depth over weir was found to be 8.278 inches.

The discharge in the first case, as calculated by Francis Weir's formula, was 4.45 cubic feet per second. As calculated by Fteley & Stearn's formula, was 4.44 cubic feet per second, say, 4.45 cubic feet per second.

Therefore the actual velocity in 16-inch was 3.189 feet per second, and the discharge was at the rate of 2,875.910 gallons per day.

The discharge when the 12-inch gate was closed, as calculated by Francis' formula, was 5.724 cubic feet per second; by Fteley & Stearn's formula, was 5.711 cubic feet per second. Therefore the actual velocity in 16-inch was 4.1 feet per second, and the discharge was at the rate of 3,696,675 gallons per day.

Calculating the velocity by means of Neveille's formula we get a velocity of 5.13 feet per second, and discharge of 7.156 cubic feet per second, or 4,624,722 gallons, or 25.15% greater than the actual discharge.

Using Fteley & Stearn's coefficient (143.1) in the general formula, we get a velocity of 6.66 feet per second and a discharge of 9.29 cubic feet per second, or 6,003,867 gallons per day, or 62½% greater than the actual discharge.

Using Kutter's formula with coefficient we get velocity 6.1 feet per second, and a discharge of 8.509 cubic feet per second, or 5,499,128 gallons per day, or 48.7% greater than the actual discharge.

Using Kutter's formula with coefficient, N— .011, we get a velocity 5.382 feet per second, and a discharge of 7.507 cubic feet per second, or 4,800,503 gallons per day, or 29.8% greater than the actual discharge.

By substituting in the general formula the actual velocity found, (or 4.1 feet per second), we find the true value of C for the case at hand, to be 87.4.

The difference between the actual and calculated discharge in the above example, are about on an average of what I have found in many other experiments, and I regret that my time has been so occupied as to prevent the preparation of a paper on the flow of water in pipes, as deduced from nearly two thousand experiments. But permit me to state the following facts which I think are not generally recognized:

First, That for every size of pipe there is a rate of grade, on which, if the pipe is laid, the discharge will be a maximum. In other words, a vertical pipe will not give the maximum discharge.

Second, That the smaller the pipe and greater the coefficient of roughness, the nearer will this grade approach a vertical line.

Third, That for a given depth of flow in a pipe (not working under pressure) there is but one grade on which said pipe can be laid, in order that said depth of flow may remain constant throughout the length of the conduit.

The first statement shows the necessity of the intake pipe (running through the dam) being larger than the main line to the village or city, unless perchance the pipe is laid on the grade for maximum discharge.

The third statement shows that it is not always necessary to enlarge a water or other conduit, if it is wished to admit a certain quantity of water or other liquid at a point along the line of the conduit. For example: At Portchester, N. Y., there is laid a 10-inch vitrified pipe (sewer) on a grade of 5%, and an 8-inch pipe (on a 1.25 per one hundred feet grade) enters the 10-inch conduit at a point B. According to Kutter's formula the capacity of the 10-inch is 276 cubic feet per minute, and the 8-inch 74.5 cubic feet per minute. Now, when the 10-inch conduit is running full at a point A, 140 feet up from point B, the cross-section of stream at B, on account of acceleration of gravity, is so reduced that the total discharge from the 8-inch line (when running full one hundred feet back from B) was easily admitted, and at a point C, 200 feet down the grade from B, much more water could have been admitted, but I did not have the water.

At Waterville, N. Y., in 1888, I found that in a 12-inch vitrified pipe conduit, on an 11 feet per 100 grade, for a distance of 430 feet, that when half full, or 6 inches deep at the inlet, (point A) at a point 60 feet from the foot of grade (or point B) the depth of water was but 2½ inches; therefore the ratio of cross-section was 57.6 to 17, or the cross-section of stream at the lower point was but $\frac{1}{3}$ of the cross-section of stream at inlet.

When water was 2½ inches deep at inlet, it was but a little over one inch deep at the point B.

Again it was found that with a 12-inch conduit on a grade of 0.6, 100, 1,100 feet long, running one-half full, or 6 inches deep at inlet, it discharged a stream 5 inches in depth.

When three inches deep at inlet it discharged a stream 3 inches deep, or there was no increase in velocity.

Tests for velocity by means of floats varied, probably due to the floats adhering to the side of the pipes. Sawdust and colored water, however gave similar results, and the actual velocity in the 12-inch vitrified conduit, 1,100 feet long, on grade of 0.6: 100, when 2½ inches deep, was found to be 2 feet per second, or more accurately, 115 feet per minute, which is 1.906 feet per second.

When running 6 inches deep at inlet, and 5 inches deep at outlet, on 0.6: 100 grade, the actual velocity was to be 3.8 feet per second. Kutter's formula gives 3.49 feet per second; therefore a 12-inch vitrified conduit running ½ full on a 6% grade, discharged 7.05 cubic feet, or 42.77 gallons per minute more than the calculated discharge.

The hydraulic mean radius being the same for a pipe running full, we can say that a 12-inch vitrified conduit when running full, will discharge 85.55 gallons per minute, or 133,192 gallons per day more than the calculated discharge by Kutters formula.

If there is such a discrepancy between calculated and practical discharge for a 12 inch vitrified conduit on the grade mentioned, how much greater will be the variation when both grade and size of conduit is increased.

From the above conclusions can be drawn :

First, That Kutter's formula, as used, will not give sufficiently accurate results for a 12-inch conduit when the grade exceeds 0.6: 100 feet.

Second, That the grade which will insure a uniform velocity in a 12-inch conduit, when running one-half full, is less than 0.6 per 100 feet.

Third, That a 12-inch conduit calculated for discharging a certain quantity "Q" must not have admitted into it any increments "Q", if the grade is much less than 0.6 per 100 feet.

The idea that I wish to bring forward by the preceding remarks in connection with my third statement, is not that it is advisable to lay a conduit gradually decreasing in area as it reaches the outlet. But to take an example : Suppose a conduit to have a uniform inclination from a point "A", where it receives a quantity of liquid "Q", to a certain point "B" down the grade, and that no increments are added in the distance "A" "B", then there is but one case in which the conduit at "B" is necessarily as large as at "A", and that is, when the acceleration due to gravity is just equal to the frictional resistance within the pipe.

Now, very few conduits are run on grades that bring about this quality, and as a consequence the velocity constantly increases from "A" to a certain point "C", which may or not be beyond the point "B". At the point "C" the maximum velocity is obtained, and if the grade and size of conduit remains constant, the velocity will not change in said conduit from the point "C" to the end.

As before stated, I do not mean to say that a conduit should decrease in size as you near the outlet, rather that increments of liquid can be added, and in many cases, as in the Portchester case, much can be added, and no increase in the size of the conduit is necessary. It matters not what may be the length of the conduit, Kutter's formula gives the same result—a mean velocity, no matter where, or at what point A B or C you may apply it.

In other words, to design a system of conduits, leading from several sources of supply and running (not under pressure) into a reservoir, or in designing a system of sewers, it is not always necessary to increase the size of your main conduit at its junction with a lateral, simply because, if you adhere strictly to formality, it would be necessary to do so.

Thus it will be seen that many conduits are built too large (especially sewers) not because of great error in assumptions, but because of a failure on the part of some engineers to use formulæ intelligently.

When we have a formula given for one thing and use it for another, we must expect erroneous results.

In a great majority of cases, acceleration of gravity is far greater than resistance to flow; of course if we consider them equal to each other, we err on the side of safety, but safety factors should not be used in such a manner as to materially increase the cost of public works without necessity for it. I think that in the preceding remarks, I have demonstrated that there is a necessity for more accurate knowledge of the flow

of water in pipes, and I would like to say more on the subject, but as I am down on the programme to—hammer water a little, I suppose it is time to accelerate my velocity and approach the end.

For some reason or other, I started my investigation of the so-called "water hammer" with an idea that it was not Norwalk eels, but some kind of a devil in the pipe, that caused such enormous pressures; later I thought that it was but the resistance offered by the devil or the eel at being so quickly stopped from making his exit, and finally I concluded that *even* water could act like the *devil*. With this thought as a basis, I went to work buying gauges quite frequently and experimenting when I had one. The conclusions reached were:

First, That "water hammer" is the pressure indicated by the gauge when a stream of water flowing through a conduit is suddenly stopped.

Second. That the total pressure indicated is a measure of the work performed in stopping the stream.

Third. That water being a nearly perfect fluid, the whole length of the conduit performs work, or more correctly every square inch of the interior surface of the conduit must resist the blow in pounds per square inch, that is indicated by a gauge placed on said conduit.

Fourth, That the "water hammer" is independent of the static pressure.

Fifth. That the intensity of the "water hammer" increases as the time expended in closing the aperture decreases.

From the above it will be seen, that if the weight of the column of water stopped be multiplied by the velocity per second, the result will be the total work performed in one second.

I will describe, for example, an experiment:

Thirty-six and two-tenths feet of 1-inch pipe were connected with a reservoir on such a grade (about 10 feet total fall) that said pipe discharged 107 pounds of water in one minute and twenty-five seconds, or 1.26 pounds per second. The pipe held 13.25 pounds of water.

From the above data it will be seen that the velocity was 3.44 feet per second. Now, if the water was stopped in one second, the work performed on an area of .005454 square feet (area of one inch pipe) would have been 13.25 x 3.44 = 45.53 pounds. Now in addition to the above there was another column of water moving and had to be stopped because the water was sixteen inches deep in the reservoir over the inlet. Therefore we must add .453 pounds x 3.44, or 1.55 pounds which added to 45.58 pounds gives 47.138 pounds "water hammer", on an area of 0.7854 square inches (area of one inch pipe). Therefore on an area of 1 square inch, the effect was 60 pounds. By actual experiment this is found to be the case.

Again on the same line when greater or less time than one second was used in closing the outlet, the calculated pressure agreed with the actual pressure recorded by the gauge, within a small percentage. The error was probably due to inaccuracy in noting the time.

On the line above mentioned a pressure of 240 pounds was noted.

In several experiments with lateral lines of small pipe, it was noticed that the recorded pressure at the center of the line of pipe, was greater than at the outlet, or at a point near the main line. In one case, for instance, on a one-half inch pipe line 250 feet long, the pressure recorded

at either end was 240 pounds (four times static pressure); at the middle the pressure recorded was 300 pounds (five times static pressure). I am unable to account for this fact, unless a reaction occurred.

In my own town the main line is 12-inch, and is 22,000 feet long, (we are laying a new 16-inch, however, to increase the capacity of the works). Let us see what the "water hammer" would be in case a stream of 150 gallons per minute was stopped flowing from a hydrant in one second. Consider the hydrant attached by means of 30 feet of 4-inch pipe (including length of hydrant) to the end of the main line. We therefore have the following data :

One hundred and fifty gallons per minute is equal to .333 cubic feet per second, 22,000 feet 12-inch pipe contains 159.78 cubic feet, velocity in 12-inch to supply .333 cubic feet must be 0.424 feet per second. The 12-inch contains 9,852,275 pounds of water. Therefore if stopped in one second, we have 9,952,275 x 0.424 = 4,188,364 pounds as the blow on 113.1 square inches (area 12-inch pipe); therefore the blow in pounds per square inch due to stopping the column of water in the 12-inch main would be 3.693 pounds. To this must be added the blow to stopping the water in the 4-inch line and hydrant, which calculated in the same way gives 101.65, therefore the total blow or "water hammer" per square inch is 3,794.65 pounds.

In order that the static pressure of 60 pounds may not be increased, it will be seen that it would require (37946 : 60) equals 63.2 seconnds—say one minute of time be expended in closing the hydrant under the circumstances cited.

But it is about time I closed and gave others the minutes that justly belong to them, and will only say that I well know that we are all liable to make mistakes, and if in rapidly preparing this paper I have made any errors in computation, or have in any way been working under a wrong judgment, or impression, I trust that others will kindly point out my mistakes.

I believe that this Association should be interested in "more accurate knowledge of the flow through pipes," for upon this accurate knowledge depends the expenditure by us of vast amounts of private and public money.

THE PRESIDENT : This is a very exhaustive paper and doubtless will prove valuable to the convention and to our literature. Is there any disposition to criticise or discuss it? It seems hardly fitted for discussion. Since Mr. Rider began the reading of his paper I have been gratified by another illustration of the hospitable spirit that we have everywhere met with since coming to Philadelphia.

Mr. Wm. B. Bull, Prest. American Water Works Association, Continental Hotel, Philadelphia,

DEAR SIR :—We would be pleased to show the members of your Association through our works, if it can be arranged for you to pay us a visit. Should you be able to come in body, and let us know the time,

we will gladly arrange to meet you, or if not together, will be pleased to meet any of the members who may give us a call.

Very truly yours,

SOUTHWARK FOUNDRY AND MACHINE CO.,
JAMES C. BROOKS, President.

I very much doubt, in view of the fact that the local committee of arrangements has already planned to take us through one of the notable iron works in this vicinity, whether it would be possible for this Association to accept the invitation; I think that we all should be glad to have it spread upon our record and become a part of our proceedings.

A MEMBER: Would it not be well for the Secretary to acknowledge the receipt of it?

THE PRESIDENT: If we could only get the Secretary to do it. He is a very busy man and we can hardly get him to attend the meetings of the Executive Committee. Mr. Secretary, will you do it?

THE SECRETARY: If I can find time.

THE PRESIDENT: I think the Secretary will respond to this invitation, expressing our regret at not being able to accept it.

At a meeting of the Executive Committee after our adjournment this morning in reference to the appointment of a committee which was to succeed the present committee on animal and vegetable growths affecting water supplies, this action was taken subject to your approval: The following named gentlemen were recommended by the Executive Committee as such committee: Prof. A. R. Leeds, Chairman; Mr. L. H. Gardner and L. J. LeConte. Also it was voted to appropriate $150 towards reimbursing Prof. Leeds for expenses incurred last year. This action is subject to your approbation or disapproval and we will be glad to hear from you on the subject. A motion either way will bring it up for consideration.

A motion was made to adopt the recommendation of the Executive Committee. Agreed to.

MR. MILNE: As a member of the Executive Commit-

tee I have a separate resolution bearing upon the same point. It has been approved by the Executive Committee:

Resolved, That future appropriations to the Committee on Vegetable and Animal Growths Affecting Water Supplies be referred to the Executive Committee with power.

I move the adoption of the resolution.

Agreed to.

THE PRESIDENT: The next paper for our consideration is by H. G. Holden. Subject: The Importance of a More Uniform System of Water Rate.

MR. HOLDEN: Mr. President and Gentlemen—The question of having a more uniform system of water rates was brought up at one of the monthly meetings of the New England Association. At that time a committee consisting of persons from three large New England cities was appointed to take the matter into consideration and report at the next regular meeting. At our regular meeting the committee asked for further time, and was granted time until the next regular meeting, which will be held at Hartford in June. I understand that that committee have not yet come to any agreement in regard to this matter, and for that reason I bring the subject up before this Association.

The subject of water rates has been brought before this Association at several of our former meetings. Last year we listened to a discourse by Mr. Tubbs on the "Basis upon which Schedules of Water Rates should be Determined," but it appeared to me to be almost too theoretical to be of much benefit to a practical superintendent. Then Mr. Priddy gave us a paper on "Water Rates," and I was sorry to see it passed by without any discussion.

Now I consider there are but few matters connected with the administration of a water department of more importance both for the financial and executive management than a tariff of water rates which will be satisfactory to all classes of consumers and at the same time will also produce a sufficient remuneration to the company or city owning the works.

It is one of the rules of nature that no two bodies can be made precisely alike. This will certainly apply to water rates, for out of a large number which I have received, coming from nearly every section of the Union, I have been unable yet to discover any places which had a schedule of water rates that were similar in every respect. Of course it is not expected that the charges can be the same in all places; for one town might be able to furnish water much cheaper than a neighboring town

having different facilities for getting a water supply. Still I am unable to comprehend why a more uniform system for making rates cannot be adopted. Take, for instance, the family rate. It is fully as important as any charge in the schedule, but I find there are quite a variety of ways for assessing it, some of which I should judge would be very unsatisfactory.

Many places assess the family rate by the number of rooms in the house, so that a family of two persons living in ten rooms have to pay a higher rate than a family of ten persons living in two rooms. Some cities charge by the height of the buildings in stories. Others charge by the number of feet of frontage. Then there are many who base their rates on the assessed valuation, so that a small family living in a two thousand dollar house have to pay more than a large family living in a one thousand dollar house.

The most equitable way now appears to be to charge either by the number of persons or else by the family irrespective of size. The consumption or water does not depend so much upon the amount used for legitimate purposes as it does upon the quantity which is wasted, either through negligence or defective plumbing.

The duties which fall to the lot of a country boy on a New England farm are many and various; and I remember well the time when, in addition to numerous other duties, I was required to bring two pails of water every morning, noon and night from a spring located about ten rods from the house. These six pails, or about twelve gallons, of water, with the addition of an occasional tub of rain water, sufficed for the daily domestic use for a family of six persons. There was not much water wasted in that family either; nevertheless they are all living to-day, enjoy good health, and two of the members have passed the age of four score years.

In the winter of 1883 I made a series of experiments regarding the use of water in private families; but the memoranda has been mislaid, so I am unable to give the result only approximately.

I had at that time one thousand and seventy-nine meters in use. The price charged for water was twenty cents per thousand gallons, and the minimum charge for metered water was fixed so that it would allow a consumption of sixty thousand gallons or less for twelve dollars per year. Two hundred and ninety-four of these meters were set on private residences, having all the modern style of fixtures and conveniences. One hundred and twelve meters were set on tenement houses, having a sink and water closet for each family. One hundred and fifty more were set on cheap tenement blocks, which had only one tap for each family. The remainder of the meters were set on manufactories, stables, hotels and other places where it was difficult to establish satisfactory rates in any other way.

An examination of the meter books showed that of the private residences over ninety per cent used less than sixty thousand gallons per year, and over fifty per cent of these used less than forty thousand gallons, while some went as low as twenty-five thousand gallons, and these were not families having a small number of occupants either, for a careful examination of the inspector's books showed that full as much water went through the meters at houses having only four or five persons as in those which were larger.

I remember of one case in particular. It was a house occupied by a family of eight persons, the head of whom was a retired professor of mathematics. The amount of water used in that family was so small that I came to the conclusion that the meter must be out of order; so I called one day for the purpose of taking the meter off to have it tested. On stating my errand the professor said that he was glad that I had come, as he was aware that the meter was out of order, for he had measured with a gallon measure all the water which the family had used for twenty-eight days, and found that the meter had registered during that time just seventeen gallons, three quarts and one pint more water than had been used. I was unable to get at the number of persons in the tenement blocks, as the families were continually changing; but I found that the tenements having water closets used, on an average, more than double the amount of water that the tenements not having them did; but since that time there has been so many improvements made in both the construction and location of water closets, it would seem that there was now no occasion for a great waste of water.

From these observations I have come to the conclusion that the most satisfactory as well as the easiest way to determine the family rate is to charge by the family, irrespective of size, and to put the water closet price at a reasonable figure, providing that the closet is of an improved pattern and self-closing. Charge double rates at least for all other kinds.

Water is rarely wasted in bath tubs or in set tubs, and as an inducement to have them in more general use I would recommend a low rate for both.

The amount of water used through garden hose in a legitimate manner is much smaller than many would imagine, but when a hose is left running without any one holding it, or when it is tied to a stake or tree and left to run, then double rates at least should be charged. No definite rule can be made in the matter of charges for other fixtures, but each city should be governed by the uses for which water might be wanted, always endeavoring to have the rates adjusted so as to be equally favorable for all.

I have offered these suggestions regarding water rates, hoping that ample time will be allowed for discussion, and while the advantages to be gained by having a uniform system of water rates may not be appreciated by the older cities, it would give a chance for new works to start off in a much better manner than they have usually done.

I have been unable to find many places which had rates that were perfectly satisfactory. Rates can be easily reduced without creating friction among the customers, but let any rate be increased, trouble is sure to follow. And many water departments for that reason prefer to keep on with unsatisfactory rates rather than to withstand the trouble and dissatisfaction that would be caused by making changes.

THE PRESIDENT: Gentlemen, this is a subject in which we are all interested and Mr. Holden is ready to answer any questions in reference to his paper.

THE SECRETARY: Where do you get your water supply?

MR. HOLDEN: The water came from the Merrimac river, direct from the New Hampshire hills. There were no typhoid germs then, although, according to Prof. Sedgwick, there are a few now. But in the better class of houses, having all the modern conveniences and improved fixtures, there is really no advantage for a company to set meters. In the city of Lowell the meter rates are 20 cents a thousand gallons. The minimum rate is $12, allowing for that price 60,000 gallons per annum. Many families having fixtures which rate over $12 put on a meter, especially private residences, and they usually save something by doing so. The fixtures usually found in these houses are kitchen sinks, one or two set basins, bath tub, water closet and hose. Some also have a stable supply. The regular rates exclusive of the stable would be about $20.

THE SECRETARY: They probably save money.

MR. HOLDEN: Yes.

THE SECRETARY: It seems to me the meter system is to be the solution of the rate question.

MR. CHASE: I would say some fifteen years ago I had a meter attached to a private house and found they used 100 gallons per day, or a little over twenty gallons per capita. They were a very cleanly family. The husband, I suppose, received an income of perhaps eight or nine hundred dollars per year—say three dollars a day. The washing was all done on the premises, and this amount probably represented the amount of water necessary to supply the household for domestic use, with no chance to waste. I do not suppose that they stinted themselves. I have had very large experience in carrying water to supply a family, and it is astonishing how little water people can get along with if they choose. I remember an instance when visiting a New Hampshire family, I asked for a drink of water and the lady took me out and got me a glass of water, and I drank what I wished and started to throw out what was left; she took it and turned it into another pail, saying that every drop of water had to be carried fifteen or twenty rods and she did not propose to waste any of it. The company I represent now charges 35 cents per 1000 gallons, and we

have a minimum rate of $10, which allows an average of 130 gallons per day. I have found very few people, no matter if they did have a whole line of fixtures with a garden hose, who used water in moderation, that used more than the minimum. They use that amount and do not exceed their limit.

THE PRESIDENT: Is $12 the minimum rate.

MR. CHASE: Ten dollars—they very seldom run over, unless there is a leaky water closet and then there is the devil to pay as it will run the bill up to $20 or $30. I can illustrate the effect, perhaps, of the attachment of meters, which I think really is the solution of the whole matter of the water rate business, by a statement as to eight consumers where we attached meters, where the water was used for general purposes, and where we got $150 per year rent, at the assessed or estimated rates. The meters developed the fact that they were using about $800 worth of water at the regular meter charges, and as soon as they found that out they stopped the waste of water and brought the rate by meter down to about $200 a year, so that we were the gainers, reducing the water consumption 75%, and increasing the water rate 33%, which is a pretty good illustration of the advantage of the use of water meters; and the reason that they are not in use exclusively is because the corporation has not the money to apply them or do not believe in them. We believe in treating the customer liberally, furnishing the meter and merely charging him for the cost of setting, and then only a minimum sum of $10 a year which represents an outlay of $15 to a house. We only apply them when we think there is a great waste or when the customer really desires it.

MR. ALEXANDER: I would like to ask Brother Holden a question in regard to meters. You have how many meters?

MR. HOLDEN: We have very few meters in Nashua, I think less than 100, and our minimum rate $16.00 per annum a house. I consider that the fewer meters we have on dwelling houses the better off we are. We only meter places where we cannot establish a satisfactory

rate, such as factories, large stables, hotels, etc.; we also put meters on school houses and public buildings.

MR. ALEXANDER: You mean that you are not in favor of the meter system.

MR. HOLDEN: I am in favor of it where you have a limited supply of water.

MR. ALEXANDER: I would like to know whether your company own the meters or whether the property owners own them.

THE PRESIDENT: That question comes up to-night, and if you are present you will probably hear something said to the point.

MR. STEBEN: Mr. President, the question of water rates is one which I have studied for about six or seven years, and after conferring with the different water rates with the principal cities of the United States and Canada, I find that it is a very difficult matter to establish a rate to suit everybody, in fact almost impossible.

Our system of charging is by the number of rooms and inmates. For instance, if we have a house with six rooms and four inmates, without bath and water-closet, it would be ten ($10) dollars a year, and a house with ten rooms and seven inmates would be seventeen ($17) dollars. Where they have all the necessary fixtures, that is to say the bath or water-closet, our water rates average about sixteen and fifty cents ($16.50) a year. And still a great many of our consumers find that the rate is too high. I do not know but in some cases they are right enough, as I do not believe that charging by room is an equitable way. I think, that the water rates should be charged according to the number of the family. It is true that the manager would have to make a new list every year, so as to keep track of the increase in the family, and he would be put to the trouble of making a yearly inspection, which would entail a great deal of work, as far as he is concerned.

There is no doubt that the fairest way of charging for water is by the meter system, but the great difficulty is that it would necessitate a very large expense or outlay by putting in meters in every house. On the other

hand, every consumer would be satisfied that he was not paying for more than he was getting, and I think it is the only true way of getting at it. As far as a private company is concerned, if they would adopt the system of meters there is no question but they would derive a great benefit from them. As far as our company is concerned we have but six meters in use. I may say, that we would have more only that we are so situated that our contract will soon expire, and we expect that the corporation will buy the works, if not the present disposition of our directors will be to adopt the meter system.

I might say with reference to the little experience I have had with meters, that we had supply water at a price of seventeen dollars ($17) a year, $25 and $30, and we find that those who were paying $17 before they had a meter and charging at twenty-five cents a thousand gallons, the rate was $20 ; the one paying $20 or $25 at the same rate for $30, and the one that was paying $40 a year at the same rate, after the meter was in, his yearly water supply amounted to $65, and everyone claimed to have been as careful as possible with the water, so these figures will show the advantage of using water meters, especially with large consumers.

THE PRESIDENT : How large families ?

MR. STEBEN : We have no meters connected in private houses. The meters which I just spoke of were in laundries and livery stables.

MR. BENZENBERG : We have established our regular rates by rooms, and then by the fixtures additional—a room rate entitles a consumer to all the water he can use for family use ; extra fixtures as bath tubs, water closets, urinals, lawn sprinklers, etc., are specially rated, and we make a difference in the rate as to the style of the water closets, etc. A tank closet is less than a hopper closet and so on, but at the end of our rules, that is what I here wish to call attention to, we have a table which specifies the amount of water that the consumer is entitled to under an annual charge. For instance, if the annual rate amounts to $7, he is entitled to 100 gallons of water per day—I don't remember the exact amount, but that is about it—the number of gallons are

figured down, to the single gallon, but he is entitled to 100 gallons per day for the year around. If the annual rate is $10.50, he is entitled to 150 gallons per day, and so on, enumerating the annual rate from $5, which is the lowest rate, up to $150 a year. The table is a guide for the consumer or the city, for it is specified that if he uses less than the amount in the table opposite his rate he has the privilege of putting on a meter, and if the city is satisfied that he uses more, then the city has the right of forcing a meter on the premises, and of making him pay according to the actual consumption; but the table which specifies the number of gallons which he may use upon an average per day per year according to the regular rate at which the premises are rated, are taken as a guide, and of course they are based upon our meter rates.

MR. HOLDEN: Mr. President, it seems to me that such rates would require a large amount of territorial work and a large amount of inspection to find out whether the consumer is really using more than he is entitled to or not and to see that he pays for all he does use.

MR. BENZENBERG: An inspection is made as to his fixtures unless he has a meter—the number of rooms, and the fixtures are reported, and that is for the regular rate. When rate is established we do not make a daily or weekly or monthly inspection to ascertain whether he is using that amount of water, he is entitled to it. We do not know whether there is any special waste or not. It is merely a guide, and a part of the contract, and it enables the city to force a meter on at any time in case they think there is any excess of water used over and above that which he is entitled to use.

MR. HOLDEN: The question is whether water can be sold as any other commodity. I cannot understand why houses which have a large number of rooms should be charged more than those that have less rooms.

THE SECRETARY: Certainly every water fixture put on makes a possible chance for leakage. I think the charge on the number of fixtures is the most proper way. Then charge according to the character of the fixtures, a

self-closing fixture being charged at a lower rate than an ordinary fixture.

Mr. Steben : My experience is that in the cheapest class of houses, where they have a family in every room, and in some rooms two or three families, a great deal more water is used and wasted than in a private residence.

Mr. Holden : We charge water bills to the owners of the properties.

The President : They are made responsible ?

Mr. Holden : Yes ; our bills are made out to the owners of the properties. In case a man leases a house the water rent is paid by the owner. This is done in case the tennant should neglect to pay.

The Secretary : What is your system ?

Mr. Holden : Our own system is very simple. We charge for a family $8 per year and they are entitled to all the necessary fixtures except water closet, which, if self-closing and of approved pattern, we charge $4 a year, also $4 for hose. If a person has a stable with water we charge $4 more, making $20 our limit for any single house. We do not collect our water rents in advance, we collect them every quarter, and are now collecting in this month of April for the previous three months; we find people are better satisfied to pay in that way, as they are then paying for what they have already had.

Mr. Alexander : I think room charging, charging for the number of rooms, is not so well as charging for the number in the family.

Mr. Gardner : Will the members of the Nominating Committee please meet in room twenty, immediately after the adjournment of this session.

After a few announcements by the Secretary, the Convention adjourned to meet at 8 p. m.

EVENING SESSION, 8:30 P. M.

Meeting called to order by Vice-President G. H. Benzenberg.

THE CHAIRMAN: Gentlemen, before taking up the discussion on the paper on ownership of meters, read at the last convention by President Decker, the Secretary has some communications to be considered.

THE SECRETARY: I have a draft of an Act now pending in the legislature of the State of Pennsylvania, and a resolution bearing upon the same, which I received from a member of the State Board of Health.

AN ACT

To prevent the pollution of, and relating to the purification, improvement, construction and use of, systems of water supply, and authorizing the State Board of Health to have supervision over the same, and providing remedies in relation thereto.

SECTION 1. Be it enacted by the Senate and House of Representatives of the Commonwealth of Pennsylvania in General Assembly met, and it is hereby enacted by the authority of the same, that the State Board of Health shall have general supervision over, and shall from time to time cause examinations to be made of, the waters used in the various places in this Commonwealth for domestic purposes, with a view to ascertaining whether the waters so used or any thereof are dangerous or prejudicial to the health of the persons using the same; and it shall be the duty of the State Board of Health from time to time to consult and advise with persons engaged in the supply of water for domestic purposes, and to recommend to them such measures as the said Board shall deem expedient and proper for the prevention of the pollution of, and the removal of impurities from the said water supply.

SEC. 2. Before any system for the supply of water for domestic purposes shall be constructed or enlarged, it shall be the duty of the person or persons about to construct or enlarge the same, to submit and furnish to the State Board of Health a full description thereof, together with such information as will enable said Board to make an examination of the water to be supplied, as well as the sources thereof, and to determine whether the system proposed will be such as to assure the purity thereof; and no system shall be constructed, enlarged or used when the said Board shall by its certificate in writing express its disapproval thereof as dangerous or unsafe to the public health: *provided, however*, That any party aggrieved thereby may appeal to the Court of Common Pleas of the county wherein it was proposed to construct, enlarge, or use such system of water supply, and such Court shall proceed to hear and determine such appeal; *and, provided, further*, That, nothing herein contained shall be so construed as to prevent the ordinary repairs or extensions of the distributive system of any water-works.

SEC. 3. It shall be unlawful to put the carcass of any animal, or any spoiled meat or fish, or any putrid animal substance, or the contents of any privy vault, or any manure or any liquid containing in suspension or solution any substance rendering such liquid dangerous or deleterious to health, or unfit for domestic use, upon the bank or into any pond, lake, stream, or watercourse, within this State, which is, or shall at the time be, used for the supply of water to the public, or shall be tributary to any body of water from which a public water supply shall be taken: *provided*, That this Act shall not be so construed as to intefere with the sewerage system of any municipal corporation, or with the cultivation of the soil in the ordinary methods of husbandry, or with boating, bathing, or fishing, or so as to in any way interfere with or prevent the operation and drainage of coal or ore mines, so as to impose any greater liabilities or restrictions thereon than now exist.

SEC. 4. Any person violating the provisions of this Act shall be deemed guilty of a misdemeanor, and shall be sentenced, upon conviction thereof, to pay a fine of not more than $500, or to undergo an imprisonment for a period of not exceeding six months, or both, or either, at the discretion of the Court; and when such nuisance shall be in existence at the time of the conviction and sentence, it shall be lawful for the Court in its discretion to direct either the defendant, or the sheriff of the proper county at the expense of the defendant, to abate the same.

SEC. 5. The several Courts of Common Pleas of this Commonwealth shall have and exercise all the powers of a Court of Chancery for the prevention and abatement by injunction of the acts hereby declared unlawful, upon a bill filed for that purpose by any municipality, or by any corporation organized for the purpose of furnishing water to the public whose water supply is polluted or rendered unfit for domestic use, or by any person who may be specially injured.

SEC. 6. It shall be the duty of the State Board of Health to report every violation of this act to the District Attorney of the proper county, and furnish to him a statement of the facts in relation thereto.

Resolved, That it is the sense of this Association that the principle of State inspection and supervision of sources of public water supply in order to protect the same from pollution, is one of fundamental importance. And therefore,

Resolved, That this association heartily endorse the efforts now making to obtain such legislation in the State of Pennsylvania as shall ensure official oversight of public streams and thus prevent the poisonous contamination of waters furnished to her citizens for domestic purposes.

Resolved, That copies of these resolutions be forwarded to the Secretary of both branches of the Legislature now in session at Harrisburg.

A motion was made to adopt the resolution.

THE SECRETARY: I second the motion; this seems to me to be a step in the right direction, though really the control should be in the National Board of Health, so that the control of streams and other sources of sup-

ply could be complete. A city in one state may draw its water supply from a source wholly or in part in another state, here national action alone can avail. The taking up of the matter by individual states will, probably, in time lead to National control. This is a question of great interest to us and one on which the influence of the Association should be brought to bear.

MR. MILNE: Does this act interfere with Local Boards of Health? Does it supersede the local boards?

THE SECRETARY: I should say not. I have only read it here, but I do not think that there is anything that would interfere with the operation of the local board of health.

MR. ALEXANDER: It is in sympathy with local boards of health. I was at the Monongahela House, Pittsburg, at the time the bill was drawn up, but I am sorry to say that I think our legislature has put its foot down on it; I think that it is knocked out.

MR. MILNE: I think that the act is rather sweeping in its character. I am in full sympathy with what is expressed in the act and in giving the power to the State Board of Health, and I rather think that the State Board of Health is better than a local board of health on the question of preventing the pollution of streams or local water supplies. I speak from a general knowledge that I have concerning the operation of the State Board of Health laws of the State of New York, and also of the local Board of Health of the city of New York and of the city of Brooklyn. Those Boards are now in a very efficient condition, and under a very high order of administration, and their acts are generally viewed with a very great deal of sympathy by the people, who of course are interested in the development of any feature or instrumentality that will promote the efficiency of the health of the commonwealth; but I view with alarm the feeling that does not consider the claims of local boards of health. I view it from a judicial standpoint rather than from any other.

THE SECRETARY: This State Board of Health now exists. This is simply to enlarge its powers. I understand, from what little I have studied it, that it would

not interfere with the operation of the local boards of health. The local board of health cannot control matters outside of their district. The idea of this act is to supplement the local boards of health.

MR. GARDNER: It seems to run parallel with that adopted by the laws of Massachusetts.

THE SECRETARY: It is very similar to the law now in force in Massachusetts.

MR. ALEXANDER: That is the thing we tried to imitate; it is the same language, the same thing, and gives to the Board of Health the same rights.

THE SECRETARY: The operation of the Massachusetts Board of Health law has been very successful and beneficial.

THE CHAIRMAN: Gentlemen, of course the Association should be guarded as to just what they approve or disapprove of in the matter of legislation. The resolutions in themselves do not directly approve of the language of the act, but they recommend the furtherance and the adoption of such regulations by State Boards. I cannot see anything in the resolution that will at all embarrass the Association at any time hereafter. What is the pleasure of the Association?

The question was then called for.

The question being on the adoption of the resolution, it was agreed to and adopted unanimously.

THE CHAIRMAN: The next business in order is the discussion on the paper submitted by Mr. Decker on the third day of the last session, discussion on which was at that time deferred until this meeting. The title of the paper is, "Who should Own the Meter?"

MR. GARDNER: Mr. President—At our last meeting, our ex-President, Mr. J. H. Decker, presented a very interesting and carefully prepared paper on the general subject of the ownership of meters. This paper was read toward the close of the meeting. Its merits were fully appreciated, but its discussion promised to go beyond the limits of the time of our meeting. After the

reading of the paper, on motion of Mr. Tubbs, of Rochester, N. Y., its discussion was deferred to this meeting.

In now opening that discussion, and without presenting a carefully prepared paper, I desire to say that it is of interest and value chiefly to those plants which, practically, are not committed to either system. I think it will be conceded that the first practical objection to the ownership of meters by the water company is the enormous expense incidental to stocking the plants. A system once inaugurated, of ownership by either the consumer or the water company, would be difficult if not impossible to change. But aside from this, let us consider not only what policy suggests but what equity demands. Part of both we must learn from those who are compromised to one or the other of the two systems by their existing practice. Let those who may participate in this discussion free themselves from their environment and act as jurors in the case. Without having any large experience I am decidedly inclined to favor ownership of the meter by the consumer. What I may say on the subject must be deemed of a theoretic character rather than the result of any large practical observation or experience.

In New Orleans we have, so far, comparatively few meters in use, and for reasons not germane to the subject in hand. In common with other communities where there are water works, we find that on *ex-parte* statement each and every consumer is over assessed—over charged. I fancy that this is not unusual. In fact it is a chronic case or universal situation. The policy of metering family service is, I believe, a mooted question. But the larger consumers, other than the average family, should be metered under some system or other. The family service should also be metered where there is an unusually large use or waste of water. The superintendent should assess them to the full rate permitted by the charter of his company, for both the probable and the possible use of water in a given case, and then calmly and serenely await the inevitable "kick." When it comes, let him mildly suggest a meter. Let him illustrate freely, in comparison with a gas meter, and tell the kicker how he drills his wife and children and servants to turn off the gas when the light is not actually

needed, and picture him pointing significantly to the clicking meter. This may impress him with the thought of economy in his own interest. Let the kicker be asked how much a gas company would charge him for the *privilege* of an unlimited use of gas in his house. As a rule he don't know. Never bought or used gas in that way. Well, does he expect any better or more liberal system from a water works company? He don't know about that either, except that gas and water are two different things. One costs something to produce and 'tother don't. He and the superintendent get to terms after a while, and the consumer gets a figure per thousand gallons.

A thousand gallons of water! It seems to him like a liberal portion of Noah's flood. He gets out his pencil and paper and confirms his preconceived idea that the water company has been over-charging him. Why, he don't use ten gallons a day! A *thousand* gallons! Jerusalem! That will last him nearly a year! And only 25, 30 or 40 cents a thousand gallons, did you say, Mr. Superintendent? Now he has the water company in a corner. The superintendent tells him he must provide a meter of such make as is approved by the company and keep it in full repair at his own expense. To all this he promptly agrees. If, however, consumption of water overruns that one thousand gallons, then he repents his contract and is prepared to swear, and *does* swear, that the meter is made to run in the interest of the water company.

Well, he has to say *something* under the circumstances. Just as well for him to say this as anything else, provided he don't "cuss." The line should be drawn at "cussin" in all well regulated water offices. If he "cusses" his water supply should be turned off until he repents and apologizes satisfactorily and pays the fee for "off and on." It is difficult to educate the consumer to a conception of the fact that a water *privilege* is, or may be, as valuable as the actual use of water. This is more fully realized in connection with fire protection service. The average consumer is not quick to discern the identity between this and his fire insurance policy. But as to the actual use of water on his premises, whether for domestic, manufacturing or steam purposes, nothing

but a meter will convince him of the amount of water really used, and sometimes not even this.

Now, who ought to pay for this protection and education? Very much has been said in this connection as to who should provide the measure to the consumer, and this is the question now before us. The grocer and other dealers provide their scales and measures by which I am charged with my purchases, but that does not prevent me from providing my own weights, balances and measures as a check. I stand in the market house offering to sell apples or any other commodity at so much per bushel. The buyer questions the correctness of my measure. I concede his right of criticism, but I demand that he bring to me a vessel bearing the unquestionable stamp of a genuine bushel measure, which I agree cheerfully to fill. Transfer the illustration. As superintendent I decide that a certain factory is using so much water. That it can do with less is none of my business. I assess it as I find it. The owner of that factory questions my estimate, and we agree to the arbitrament of the meter. He must bring this meter and I must be satisfied that it is of a proper make and that its registry is likely to be approximately correct. Further, if this man deals with me continually and regularly, and wants me to sell him my goods by his standard of measure, I will demand of him that he keep his bushel measure, or his meter, in good order and up to standard of correctness. It is his measure against my measure. My measure of assessment covers what he is fairly entitled to use without imputation of willful waste. His measure or meter covers not only this, and a check against my estimate, but also what economy he can achieve through his use of a meter.

Who should pay for this?

Certainly, no water company desires to curtail or diminish its output by meter system or any real or supposed restriction. What it *does* want is pay, at some price, for every gallon it pumps. After the most careful superintendent has made up his yearly budget and compared his assessments and receipts with his pumpage, he thrusts his hands in his pockets and whistles a low, long drawn whistle over the deficit. That deficit lies in waste of one sort or another. Something, in other words, that

no pay has been received for. There is waste of a willful sort, and a waste growing out of the idea of an unmeasured privilege. It is this last which has to be guarded against. It can only be done by a meter. No superintendent avowedly assesses for a waste privilege. But when occasion serves, he ought to get it into his bill, if he can, and prescribe a meter for the recalcitrant consumer.

I repeat that, so far, I favor ownership of meters by the consumers. As for freedom of access to such meters by the water company and enforcement of their proper care and repair, why that is a matter of original understanding and contract. Meantime the company should own an adequate number of meters, the gratuitous use of which may be given to the consumer pending repairs, in case his meter has to be removed for the purpose.

The charge of a proper percentage on the cost for rent of a meter may work well where the life of a meter will warrant a reasonable annual rental. In localities where the life of a meter is short, the charge of a remunerative rental would be deemed extortionate, and it would be better water works policy and be more popular practice, if the consumer be required to buy the meter outright.

For correction of these views—yes, even to conversion from my possible errors—I await further discussion.

THE SECRETARY: As Mr. Tubbs is not here to take part in this discussion and as his views coincide so exactly with my own and are so much better expressed than I could express them myself, I will, as an argument on this paper, quote from his paper on the general application of meters.

"It is important that all of the appliances by which water collected, stored, conducted to, furnished and measured to the consumer, should be durable of their kind and fully under the control of the party making the financial investment, for on the whole of the investment made the investor rightfully anticipates an adequate financial return. This return he expects for the money paid out by him for water rights, rights of way, for water pipe, for reservoirs, hydrants, gates, engines, boilers and the depreciation and management of each of these; and if so, what good reason can be presented why he should not also receive an equitable return for the cost, maintenance and depreciation of the meter by which the water is measured to the consumer in an equitable way.

In short, a meter should be placed on each and every service attached to the works, and these meters should be reckoned as a part of the cost

of the water works plant, on which the owner is to receive his profit, and this cost and profit is to be included in the determination of the price charged for the measured water.

It has been suggested by some that the advocates of this plan might as well insist that the service pipes, faucets and other fixtures for the using of the water inside the premises should also be furnished by the water works owner. This, however, is not logical. When the water works manager has placed the meter inside the basement wall, he has provided the consumer with access to the water and an automatic measure of the quantity used, and it is no more than a part of his province to determine for the consumer the architectural designs or luxuriousness of the plumbing arrangements for his baths, water closets and wash stands than it would to determine for him the general furnishing of his drawing rooms.

When the company or municipality has furnished all that is necessary to give access to the water and the proper measuring of the same, then it is a matter of no import whether the consumer shall elect to take all his water supply from the basement or whether he shall expend his thousands of dollars in the extension of his pipes and fixtures to all parts of his mansion and in their elaborate and æsthetic adornment."

Mr. Decker: Mr. President, this is the very point on which I take issue with Brother Tubbs. I cannot conceive *how* the meter is, or why it should be considered as any part of the construction. It has no part in the pumpage nor in the distribution of the supply other than as a silent watchman to prevent dishonesty and undue uses or waste. It matters not who primarily pays the purchase money, the consumer must eventually do it, if not directly he does it in the form of an increased rate, if the supplier be a private company, or by increased taxation if a municipalty; then if the consumer pay for it, which is eminently proper as he is the party directly benefited by its application, should he not in all fairness *own* and maintain it? To explain my position more fully, let me cite as an example a not far distant city whose annual reports show an interest charge of $222,000, operating expenses $30,000, while the revenue is but $200,000, leaving a deficit of some $52,000. The city has a population of 130,000 and reports 21,000 taps, which we will assume supplies four-fifths of the population with water; and assuming the other one-fifth not using water but that they are taxpayers. To meter these 21,000 taps will cost, placing the average cost per meter set complete at $20, $420,000; the interest on this amount at 5% will be $21,000, estimating the repairs at 2½% of cost and 2½% for wear and tear or the ultimate life,

which is giving the meter an ultimate life of 20 years without repair, and all will admit this to be more than reasonable, adds another $21,000, making the annual cost of the 21,000 meters $42,000. Eighty per cent of this amount will be paid by the population supplied with water, but there yet remains 20% or $8,400 to be added to the one-fifth of the deficit before noted, making a total of $18,800 per annum to be paid by the 26,000 or one-fifth of the population who use no water nor receive any benefit whatever from it. Is it just to increase the taxation of one portion of a community for that which is simply a personal or individual benefit to the other portion and which cannot be applied to public or general use as is the case with the meter?

The Secretary: Mr. President, people who do not use water are taxed for part of the construction—I don't think it any more hardship to tax them for the water meter than for the street main for which they get no benefit.

Mr. Decker: In reply to that I would say that the cases are not analogous; the whole community almost is benefitted by the street main as by the pumping engines. They furnish protection against destruction by fire of the buildings and other property of the people, the values of vacant lots are greatly enhanced by having a vein of living water passing their front or rear that may at any time be tapped and conveyed to the premises for any desired use, while the general health of the community and the sanitary condition of the city is very materially improved by the availability and use of the water for sprinkling the streets, flushing gutters, sewers, etc. Can this be said of the meter which is placed under the side walk or in the cellar of the individual consumer and limited to his personal use?

The Secretary: The people are taxed for fire protection where the mains do not reach them at all.

Mr. C. A. Jones: It seems to me that the meter should not be owned entirely by the city or by the company—the parties to be benefited should pay the price for putting in and keeping the meter in repair. I noticed what Mr. Gardner said about devoting ourselves to our

environment; they are very apt to be forgotten—those who are benefited should pay. A consumer who is using a small quantity of water should not be charged the same as those who are using an excessively large quantity. He should have the privilege of taking the water by meter, and keeping the meter in repair. If the water company conclude that the rate cannot be assessed to its satisfaction, it should set a meter and keep it in repair.

THE SECRETARY: The trouble is will the consumer keep his meter in repair. Can the company enforce that?

MR. JONES: Our company does do it. If the meter is out of repair they give the customer notice and if he does not have it repaired they shut off the supply.

MR. RICHARDS: Mr. Diven says it will be hard on the poor man to compel him to set a meter. Your water company belongs to the city. To make a tap costs $10, then putting in the meter costs $20 and by the time the pipe is in and the meter set you have expended $25 and you have done the work at an economical rate. It is 2½ years before you get paid for your connection and meter, and by that time, perhaps, the poor man's house burns down, or some rich man gets it and the poor man does not get any benefit. (Laughter.)

MR. MILNE: This association is making progress. I have spoken many times at the annual convention on this subject; probably some people's ear drums may be tired from hearing me. Now it is pretty well conceded that it is the general sentiment of this association that the great evil of all water works administration is waste, and it is also pretty well conceded that the meter is the most effective method of checking the waste of water. That is admitted. There is really no tangible subject before us in the way of argument, either upon the application of the meter, or on the object of setting a meter. Now the point is who is going to pay for the meter. Of course, if the water company can get the private consumer to pay for the meter why it is all right; but I do not think that there is any gentleman in this convention, if he lives five years hence, but will come to the conclusion that a meter as applied to any service pipe belongs to a part of the plant. It would seem to be so in the very

nature of things. It does not matter how you talk about the water closet and bath tub—the water company has no interest in those things—they do not measure the water, but the meter does measure the water. It makes a conclusion in the mind of the consumer and superintendent; it is a maker of sentiment; it restricts the wasteful use of water. In five years from now I do not think there will be a man but who will be of the same opinion that I am now, that the meter belongs to the plant. Why, who takes charge of the meter without regard to ownership? Does the consumer? Is it not the superintendent or his subordinates? Who directs the setting of the meter and where it is to be set? Is it not the superintendent? If the meter gets out of order, who repairs it? Does the consumer? Well, if the meter is out of order, it must be repaired—does the company permit the consumer to take the meter out and have it repaired, and if it does is it repaired under the supervision of the superintendent or under somebody else's supervision, who determines that the meter is properly repaired? All these people must come under the province of the superintendent or engineer of the water works. There is no question about the jurisdiction, as to the meter. Who determines the kind of meter that shall be used? Who determines where the meter shall be located: who determines the rate per capita upon the quantity of water used as determined by the meter, and who governs the repair of the meter, and who takes the registration of the meter? The meter is really in the interest of the water department in all respects. In fact there are resolutions of the Common Council which give control over that very instrument that determines the measure of the water. Now all these things gravitate in one direction. The question that underlies this thing is not a policy, but it is the truth—it is the principle, if the water company is well fixed, its annual income determined, and it is making money, the tendency will be to the ownership of the meter, and to supply and settle all these many vexatious questions. And it is a vexing question the compelling of the consumer to pay for the meter.

Mr. Decker: I do not wish to monopolize this discussion but I do want to reply to my friend Milne. He starts out with an assertion, apparently forgetting that

an unsupported assertion may not be a fact, just as has every other gentleman who has espoused that side of the argument; that "the meter is an essential part of the construction and should be paid for by the Company;" but he fails, as they have, to prove it, or substantiate it by any facts, figures or even sound reasoning.

If the Company be a rich one, or the municipality making plenty of money from its water supply system, his position might be a tenable one, but in these cases, as a rule, the use of the meter is not demanded, as it matters but little how much water is used. The Company or department only demand the meter system when it behooves them to stop the leaks, in which case the careful, prudent consumer, and the man who uses no water is unduly taxed to correct the wasteful habits of his neighbor.

Mr. Booker: I have had some experience with meters; we have now some 10,000 meters, and I have found that nine out of ten dwelling houses where these meters are applied do not use an excess above the minimum rate—the other odd one, the tenth man is found guilty of a grievous waste. Last July there were 450 places where we felt compelled in view of the waste in our city to take some action, and after notice had been served we made a charge of $2, it made no difference whether they used $30 or $50 worth, it was the same thing. Now there remains but 67 of those 490 families who continue to waste the water. All of the 490 have discovered where the leakage was and have stopped it. The waste of water can be stopped, and as a means of stopping the waste of water there is probably nothing in the world that will compare with the meter. If the object is to reduce the consumption of water, the meter is just the thing. When you put the meter on with the idea that you are going to get rich from it, we can tell you that you are mistaken for the general use of meters will reduce your income. We are a private corporation, with a property valuation of some $25,000,000 and we have the misfortune in California to have to pay the bills we contract, by the application of meters we reduced our income so much that probably in about 100 years we would not have any water works. That is the position of our company. Every family now using

water is entitled to 1,000 gallons per day at the assessed rate, all over that is charged for at meter rates, they have to pay for exactly what they get and they certainly use the quantity of water alloted to them. We must have a meter system of some kind to prevent waste of water. We have a quarter of a million dollars in meters. We have a shop at our water works where the meters are made. Our water works are on the storage system, and it is necessary for us to store all our water supply and we cannot afford to have it run to waste, the wastage is very heavy, although it don't compare to that of some of the eastern cities. Our average per capita was 68 gals. last year, and our average rate for the total consumption was 20 cents per 1,000 gals. Now 20 cents per 1,000 gals to you, who have water near at hand, would seem to be a very fair rate, but for us, with our money invested as it is, in large tracts of land for collecting and storing water and in long and expensive conduits for conveying it to the city, it is not a large rate. Our operating expenses are very heavy and taxes which have to be met, and if they put meters into every house, our income would go so that the stock-holders would certainly have to go without dividends and we don't want that. The city of London with some 5,600,000 population has a per capita use of water of 32.62th of a gallon. Now if the city of London can get along with 32,62 of a gallon per capita certainly the city of New York can get along with a like amount. If you go to the city of New York you will find the consumption is 110 gallons per capita and Philadelphia 130 gallons, just double that of London.

There is one thing you must have in a private corporation and that is the money to run the works. The city backing the institutions as the cities do back the water works, of course is a different thing. If the water works run behind they can have an extra tax to help them out, but they do not do it with a private corporation. Nobody comes forward and says we know you have lost money this year and we will pay your bills. With us we must put on the meter; it is one of the things we are compelled to do. In our city we have the authority to compel the people who desire a large service to put in a meter, people who want a six inch service

where a ¾ inch service would be enough—they want to have a fire hydrant large enough to supply a locomotive on the roof in case of fire, and these people will only pay for the water they use, knowing that if the building burns down the meter goes with it, so they buy the meter, and we have got to keep it in repair. They might refuse to allow us to take that meter out of the place. The meter we use is the Worthington meter. We build the meters in our own shop under the Worthington patents. Now if we sell one of these to the party owning the premises we have certainly no right to take it away from there against his will. We swear that it is not registering and he swears, that it is and that is a point we have to have decided. When we own the meter we can do as we please with it, and then we are sure whether it works or not, and as a general thing it does work. Water for fire protection is a valuable thing to a man owning a large building; he wants a large service, with an expensive meter, to furnish him with an ample supply for fire protection, though he may not use as much water as a man having a small house, a laboring man earning not over $1.50 per day. If he has this large service to supply him with less water than the poor man, who gets it through a small service, pays for, he should certainly be at the expense of placing the large meter. In the year 1876 our engineer probably was here with you. I think he was, because when he got home nothing would do but they must have meters; when he came he had made a contract for meters to the extent of $500,000. Those meters were contracted for in the city of New York, although the company did not take them. In the year 1876 we began to put on meters. We were pumping 12,700,000 gallons a day, and in 1877 after we put on the meters the consumption went down to 11,900,000 gallons, and in 1878 it went down to 11,300,000 gallons. Our consumption had been 12,700,000 gallons, and it went down to 11,300,000 gallons. There was a big saving in the water, and that was a big thing, but at the same time there was a diminuation in the income. Some of you folks here who have private companies no doubt would like to know how we made out. We had a good deal of trouble with the citizens about the rate. The citizens rose up in arms, and not only went to the

State Legislature on the question of rates, but they passed a new constitution which took the whole right from the water company to fix their own rates. We are allowed to be present when the rates are fixed. They are fixed every year in the month of February. The question is whether the company should own the meter or whether the people should own the meter, and I am going to give you these figures to show you how we got along with the meters, and then probably you won't want them. In 1889 we had to stop. We had put on 12,000 meters and reduced our consumption nearly 3,000,000 gallons a day. Now we wanted to sell the water, and we wanted the money, and we were in a quandary on the question—we couldn't have both. We are continuing putting on the meters and we make the people pay for the water, but we found that when they used $50 worth we were lucky to get $5 for that $50 worth of water We collected just what we could. The meters stopped the consumption of water.

Mr. Gardner: Did you want to stop the consumption of the water or did you want to get paid for your water?

Mr. Booker: We want to reduce our consumption to a reasonable amount. Now we have got the consumption down, as the engineer would say. In 1889 we stopped, we had cut our consumption down, and we stopped putting on the meters, and our consumption went up from 16,000,000 to 20,000,000, so you see the use of meters stops the waste. I have probably wandered a little from the question. We found that our meters cost us $2.38 a year. You increase your work, as you have to have a man to read your meters, and then again the meters will break and then there are damages to pay, and when you come to investigate you will find a great many goods have been damaged. If you own the meter you have a perfect right to change it, and a perfect right to take it to your shop. Our shops are full of meters—it costs us over $2.00 a year to keep them in repair.

Mr. Alexander: I would like to ask a question in regard to damages—do you have much damage by the bursting of the meters?

A. You would probably have more here than we do. We do not have very much, as we place the meter in the sidewalk at the curb.

THE CHAIRMAN :—I think it is due to the Association that you should confine yourself a little more closely to the question in hand. I have allowed the question to vary from the one now before us and we do not wish to prolong the session, and I cannot permit you any longer without the consent of the Association to go on, unless you confine yourself to the question.

MR. ALEXANDER : The question is whether he would be liable provided the meter belonged to the owner of the property, for damages done by it.

MR. CARLIN : In regard to the meters being put in —if the meter is less than two inches, we rent it at 40 cents per month until it is paid for. The meter is put in by the plumber and the consumer takes care of the meter. If the meter is frozen he has to pay for repairing it ; if it is not registering properly he has to pay for the repairs. If the meter is over two inches, we charge $1.00 a month for it until it is paid for, then the consumer owns the meter.

MR. DONAHUE : I am very glad that this question has come up for general discussion. I am deeply interested in comparing the different ideas of managers of water works. For the purpose of hearing the subject debated, I will take the position that a water company should buy and own the meters. I view this subject strictly from the point of a private water company, as I have never had experience in connection with a municipal or city works. I do not feel that I could say intelligently or even suggest what would be best in case of a city owning its own works. "Circumstances alter cases." I know of no particular case where the foregoing saying fits more nicely than in connection with the ownership of water meters. A system adopting water meters and rules governing their use and payment for same might work admirably in one city and be a perfect failure in another. Where a city owns and operates a water works, they are in position to pass certain laws, rules, ordinances or whatever you may wish to term it,

and enforce the same, governing the use or uses of water meters, and a consumer satisfied would be apt to say that the rules were just and that the water board or council, after careful deliberation, acted wisely and to the interests of the city ; a consumer dissatisfied has no redress, consequently the superintendent of that works can say how nice his plan works. Let a private company undertake to introduce the same plan, the public would be very apt to rise en masse, condemning the arbitrary rules of a grinding monopoly. What redress, then, would a private company have?

For a private company, I think the water meter should be bought and owned by the company and should be kept under the control of the company. The meters can be considered a part of the plant just as much as can be considered a pump. The wear and tear and replacing of worn-out meters should be regarded as a general repair and wear and tear as much as the repair or replacement of a worn-out pump, gate valve, etc. Regard the original cost of the meter as part of your original investment, regard, then, the interest on cost of meters, rather than the actual cost of the meter. Let your water rate be sufficient to pay you for pumping the water, and interest on your whole plant (including cost of meters) and the wear and tear on the meters the same as any other general repair. To me it does not seem just or reasonable to require a consumer to pay for and own a water meter, the control of which must necessarily be in the hands of the water company.

Mr. Hillyer : I have been very much interested in this discussion, and though a new member, having only joined your body to-day, I beg to submit a suggestion in a somewhat different line from any that I have heard. I have had some experience in the city where I live, Atlanta, Ga., which I hope may be of some service. The meter system has been so triumphantly successful since its adoption with us by placing a meter upon every tap, that I really think it is a matter of public benefit that whatever plan or policy will most have a tendency to induce any city to pursue the same course and meter every tap, is the policy that ought to be adopted. My position is that you can hardly ever succeed in getting

lutely universal, that is, to meter every tap, if the city any city to adopt the meter system and make it absoitself has to bear the heavy expense that would be entailed; but, on the other hand, if the expense is borne by the users of water, and not by the public, it will be easier to carry the measure in the city government. It so happens that I was mayor of the city when we adopted the meter system, and was an active mover and participant in having the measure carried. I am satisfied we could hardly have adopted the meter system in Atlanta and put a meter on every tap if the city had herself been required to bear the expense. Cities are usually governed by an elected body of council members, and they are charged with the duty of making up the annual budget, and have to take care of the annual resources and expenditures, not only for water supply, but for schools, police and all other public purposes. And when you ask the average city council to appropriate so large a sum out of the public treasury as would be necessary to buy a meter and place it on every tap, and divert such a large sum from the ordinary needs and expenditures of the year, you would be very apt to meet with defeat. Take, for instance, the city of New York. Counting 400,000 taps at $20 per tap, it would cost $8,000,000 to meter the whole city. And that, possibly, is the reason that the city government of New York has always shrank from the experiment, although I suppose but few well informed persons would deny that the city would have had very nearly an adequate water supply from the old Croton aqueduct, if she had stopped all waste by putting a meter on every tap.

In Atlanta, the expense of supplying meters was placed on the consumers. There were about 2,000 houses using water, and 7,000 not using it. It hardly seemed to us to be just that the 7,000 non-users should be taxed to supply meters for the 2,000 who were users of the water. There was more or less of complaint and dissatisfaction at first, but with five years of practical experience this has disappeared. Before we put the meters on (by increased use of water, owing to growth of city and other causes), the pressure in the mains had run down to such an extent that you could scarcely throw the water from a hydrant into the second story of a

house. There was often hardly any water at all in the service pipes above the second story. After the meters were put on, the pressure speedily rose to such an extent that we can throw six or eight streams over the highest church steeple in the city from the street hydrants, and everybody has plenty of water in all the stories. In five years' time, it has hardly ever happened that the water has been thrown on a fire by a fire engine. The fire engines attend at fires, of course, but only stand as a reserve. The fire department merely hitch the hose to the street hydrants and fight the fire from them.

What the rule would be in case of a private company I have no experience by which to judge; but I am well satisfied that where the city owns the plant it is a matter greatly to be desired that every tap should be metered.

Mr. Chase: I am entirely in accord with the remarks made by Mr. Donahue in reference to the ownership of the meters. The question seems to narrow itself down to this, that in the construction of water works meters have never been taken into account as a part of the plant, and we will never get a proper settlement of the question until in the construction of the works a certain amount is laid out for the plant in that respect. Now I don't know whether the city of New York could stand the investment of $8,000,000 for meters, but they have spent $26,000,000 for the new aqueduct. It would have been a saving to them to have spent the $8,000,000 in the introduction of meters. The function of the meter is to measure the water and make an equitable adjustment of the water rate. The man who uses the water should pay for the cost of that water in proportion to what he gets; as to whether or not he wastes it, is another question, with which we have nothing to do at this time; if he chooses to waste it, let him pay for it in proportion as he wastes it. I don't see any better way than that. I think the department ought to own the meter, as it is without doubt a part of the plant. That is the simplest plan and it is the way I have always advocated. Now, the practical result as to the use of a meter is that it pays fully one-half of the income. If meters are used the income will be doubled and the consumption decreased. It is claimed that there will be a

falling off in income, but I believe that an equilibrium will be established in such a way that there will be an ample return, whether it is a private corporation or under public control.

Mr. Milne: It is well to closely criticise the question on all points. The gentleman from Atlanta, Mr. Hillyer, says that public sentiment was against the adoption of the meter system as far as it related to the city putting in the meters. If the council had been properly informed upon the subject, they would have considered it as an investment practically belonging to the water works. I refer to the introduction of the meter system. It would be a supplement to the water works, and would not reduce the income, but would increase the efficiency of the system and would tend to a practical reduction of the fire insurance rates and a greater reduction of risk of all kinds. The citizens were at last aroused, public sentiment was created and that sustained the council. Take for an illustration the $26,000,000 spent in the city of New York for the aqueduct. For what? It does not increase the pressure one iota, it has gathered up the volume and that is about all. If $8,000,000 had been spent putting in meters it would have diminished the waste and the water works of the city of New York would have been practically supplemented for a period of twenty years. These are figures based upon actual calculation. Therefore $18,000,000 would have been saved to the city of New York.

Mr. Ball: I desire to say a word on this subject. In the city of Worcester, Massachusetts, there has been a meter system in use about twenty years. Unfortunately the consumer was allowed to buy and own the meter. My own conviction about the matter, as far as I have seen its practical operation and know of it, and I have lived there nearly all the time, is that no party should own the meter except the company itself. It should form a part of the plant itself.

Mr. Gardner, of New Orleans, has spoken about water rates, and the energetic language used by consumers in relation to them: if he were to come to Worcester he would at times hear some of the tallest grumbling on the face of the earth. Let him go through the

necessary repairs of from six to eight thousand meters that belong to consumers, who do not wish them repaired (laughter), and he would find the divine right of human nature to grumble assert itself most energetically. But to come to the point. Formerly all repairs on meters were charged to the consumers. Here was where the debate came, why the city should repair a meter that *ran acceptably to the consumer*. And the end of the dispute has been that the city repairs all meters and makes no charge for it. The city gets the advantage, and a large one, too, of stopping the waste, earning this profit by the free repairs on meters owned by the consumers.

Now, on the point referred to by Mr. Milne, it was a fact that by the liberal use of meters the city of Worcester was saved the expenditure of over a quarter of a million dollars for about ten years to increase its water supply. The saving in interest for these ten years amounts to a large share of the expenditure made in the enlargement of the works.

The simple fact is, there is no such detective of waste as a water meter; I am fairly convinced of that, and that no individual consumer should own the meter, but that it should be a part of the plant.

Mr. Donahue: I want to say a few words in regard to the ownership of the meter by the company. I want to make this statement to substantiate what I said in regard to my belief that the company, if it is a company, should own the meter. Looking at it from a financial point of view, of course we are in business to make money, are not in it for love, and if we thought it was going to bankrupt our company to buy the meters and to put them in, we would not advocate the adoption of the meters. In Atlanta, Georgia, the daily consumption is 2,000,000 gallons; in Davenport our consumption is 4,000,000, about twice what it is in Atlanta, Georgia; their income is $80,000, we get $45,000. I claim our company can well afford to pay the interest on the investment of what the meters will cost. At Atlanta I figure it up that they are getting 11 cents per 1000 gallons. I don't suppose we are getting over four cents per 1000 gallons. I know our company would be glad to sell the water at 10 cents per 1000 gallons. We are selling

water now to large consumers at 5½ cents per 1000 gallons, and we pump our water twice, and now propose to filter it.

MR. MATHER: Our board was organized three years ago; myself and one of my colleagues had experience as members of council in the management of the water department for three years previous to that time, so we were fairly well acquainted with the condition of affairs. We had several large consumers that we thought were getting the water at a ridiculously low rate, and we determined at once to see what they did pay and what we could do. So we went to the City Solicitor and asked his opinion of the law. He told us that we could not touch the rate for that year. We have a custom of fixing the rate in councils for manufacturers for the year—I speak now of the special rates—possibly there were thirty or forty manufacturers who had their rates fixed in that way; so he said that as the water year began on the first of April, and as we were elected after that in the beginning of May, we could not touch the rate for that year; we then decided that we could do this: we could place a meter on them, and find out just what they were using. We did so and kept the record of it, because we have an ordinance that gives us the right to place meters on any one, provided we furnish the meters, and place them. We let the meters run until January, and then asked councils to give us a committee to meet with those large water consumers and ourselves, and during the winter months, before the time for the rate to be fixed, which duty devolved upon us, the committee met with these large water users and ourselves. We called this meeting and I had drawn up a careful statement, in fact, published a report of the year calling the attention of the gentlemen to what they were getting, and I asked them in the first place if they had read that report and they said they had. I asked if any of the gentlemen objected to any statement in report; if so, I would like to hear it. None objected. Very well—now here is one large firm paying a little less than a half-cent for 1,000 gallons of water pumped and delivered about half a mile away, and another firm paying seven-tenths of one cent, not quite three-fourths of a cent for a thousand gallons

of water delivered in this way, and here is a railroad company paying 7½ cents per 1,000 gallons delivered in the same way. Now I said, gentlemen, there is no equity and no justice in this; it is the worst sort of business and you all recognize the disagreeable conditions under which we are working. After full discussion of the question we recommended what we considered a low but fair rate for manufacturers and the councils approved it, and it is being paid. It is five cents for from 5,000 to 15,000 gallons a day, scaled down to 2¼ cents for any manufacturer taking over 200,000 gallons per day, bills to be sent in monthly—the meter to be read montly, other meters metering water for domestic purposes to be read quarterly, and that has been the rate ever since. There were firms that were paying $150 a year which have since paid $600, $800 and a $1,000. We owned the meters but we got paid for them all in less than a year. We never could devise any other way of finding out what they were using. Some of these people have cut down the use of their water 50% and have also stopped the waste; a great deal of water was running to waste. They saw the river running by and did not see why we objected to the waste. We went on purchasing meters and putting them into all the manufacturing places. We put none in for domestic purposes, but the people finding out about the saving in the water in that way began to put them in to their houses, at their own expense. Our domestic rates were 7½ cents last year and we got about five hundred meters—I have forgotten the exact number the last year—and I discovered that some had actually got water by these meters for 80 cents or $1.00 to a house for a family of five. Well, we thought that would not pay, as we had about 9,000 houses, and at $2.00 it would not amount to much, so we thought that we had better fix a minimum rate, and we did so. That minimum rate was fixed at $5.00 for each dwelling, not for each meter, because we have several rows of houses where only one meter is used, and in each house this year we charge $5.00 for the water. They can use that $5.00 worth of water or not, but must pay for more if they use more. Now we have an ordinance by which we can take out the meter if it is not registering correctly, and also if we discover any meter out of repair for any length of time,

and we can charge the consumer for that time that it did not register properly the same as when it did. Now we have raised the rate from 7½ to 10 cents, and we are putting in more meters than heretofore. I live in the center of the city, and I am met nearly every day of the year and asked by mechanics and others about this matter of putting in a meter. I say to them, "You are an economical man, you have an economical wife; if you don't waste water it will pay you. You own your house?" "Yes." And they say, "I believe I will do it;" and they are going on quietly and steadily putting in the meters. My experience has taught me that it is a good thing, and that we have been amply repaid for putting them in, and we intend to go on and put in more. Furthermore, we have compelled this year all livery stables and all laundries to put meters in at their own expense. We can put a meter on everybody, if we think that they are using more water than they ought to, provided we own it. The schedule rates are $8.20 for a three story house and $6.55 for a two story house on streets; $6.20 and $5.50 on alleys. I have never been able to see why this commodity should not be disposed of precisely like any other commodity put on the market. I have not been able to discover why the same business management should not be injected into it. It has been a mystery to me why business men conducting their own business in a successful manner, when they are elected to councils or appointed to the business of managing the water department, cannot bring the same level-headed business management into public affairs that they use in their private affairs. That has been my policy, and it is today, and I believe that there are cases where it would be advisable to compel people to put meters in houses, possibly where the city might do so, but water departments vary so much in their characteristics I don't think a general law can be made applicable to all.

Mr. Decker: As it is now growing quite late, I ask the privilege of closing the discussion. I desire to thank the gentlemen who have so ably discussed the paper. I appreciate the attention it has received at your hands, which has been vastly greater than I expected when I prepared it a year ago. Then I had some misgivings as to my being able to maintain my position in the face of

the opposition I knew it would encounter from so many able and experienced engineers and managers, but thanks, gentlemen, to you who have argued from either side of the proposition. You have fully substantiated my theory, "That the consumer should pay for the meter;" if not directly you do so indirectly; it is the old story of the drummer and the overcoat in the expense bill. "You don't see it, but it is there just the same,"——

——I wish to say further, I want it to be distinctly understood that I am wholly and unequivocally in favor of the use of the meter. I believe that system to be the only true and equitable mode of supplying water, both for the supplier and the consumer. While I have argued the question from the side of consumer ownership, I am free to state that experience and practice have compelled me to adopt a slightly different line of policy, in that when we elect for any reason to place a meter, to give the consumer the option to purchase and maintain it or to pay a fixed rental and we maintain it. Where the consumer elects to take a meter he must purchase and maintain it, and is further required to pay a minimum rate.

The Secretary: It may be true that in the case of department ownership the consumer really pays for the meter, indirectly; so does the man who rents a house in time pay for it in rent, but the title still remains with the landlord, and that I consider the essential point with the meter—where the title is, there is the control. So, while the title to the meter—the ownership of the meter—rests with the supplier, he has absolute control of it.

The President: Unless further discussion is called for we will close the discussion on this paper. The next order of business is the question box. I believe there is but one question received, and there has also been, I understand, only one or two voluntary papers received. One from Mr. Fanning in reference to the Versailles water works. As it is in the printed form and has been distributed, we will dispense with the reading of the paper and it will be printed in the proceedings. It is not a subject that would be likely to be discussed, anyhow and you can read it at your leisure. The other volunteer

papers, if approved by the Executive Committee, will also be printed in the proceedings. The question that has been submitted will be read by the Secretary.

Question: What objection could there be, if any, to the appointment of a committee of three by this Association to make an examination and short report upon the exhibits, as made by the associate members at each meeting, allowing them to commend especially meritorious or new devices properly belonging to water works, or for water works uses?

There being no further business to bring up, the Convention was adjourned until Thursday morning at 10 o'clock.

THIRD DAY.

THURSDAY, April 16th, 1891.

The President called the Association to order at 10 a. m.

THE PRESIDENT: The first business this morning will be the consideration of applications for membership.

THE SECRETARY: I have the aplication for active membership of G. W. Hinshaw, Secretary Water Works, Winston, N. C.

On motion, the rules were suspended and the Secretary cast the vote of the Association for the above applicant.

THE PRESIDENT: The Association will now have the pleasure of listening to a paper on "Water motors, Cost of running, and their economy in connection with water works systems," by Stephen E. Babcock, of Little Falls, which, through some misunderstanding has been omitted from our printed programme. We have printed copies of this paper which will be distributed among the members.

WATER MOTERS, COST OF RUNNING AND THEIR ECONOMY IN CONNECTION WITH WATER WORKS SYSTEMS.

Gentlemen of the American Water Works Association :

I have selected the subject of Water Motors, for the reason that I am in receipt of so many letters of inquiry as to the amount of water used, the actual cost of running, and their comparative economy; and as there is so little that seems to be obtainable in print, I have thought a paper on this subject might be of interest to the members of this Association.

I am able to give the actual amounts of water used and cost from meter measurements on a number of motors now in use in connection with the Little Falls, N. Y., Water Works, as, with one exception, all motors in use there are connected up with meters. I have thought that perhaps the Little Falls works, of which I am chief engineer, is the only works where so much meter data bearing on this subject is attainable, and that it was my duty and privilege to bring it in, I hope, tangible form to your notice, trusting that it might be some little guide to determine whether it is desirable and profitable to introduce more extensively the use of water motors in other localities. I do not propose to discuss the relative merits of the different styles of motors now on the market, as this, to my mind, does not seem to be the proper time or place, nor is it my province to ventilate their variously claimed superiority. I shall merely state the general principles of the devices and the details of construction as claimed. Water motors are divided into two classes, one a jet, the other piston motors. All jet motors produce their effect by impact, by pressure, or by reaction, but never directly by the weight of the water. Hence they may be classified as impact, hydraulic pressure, or reaction wheels.

The impact wheels have radical or hollow arms on which the water acts more or less perpendicularly. The pressure wheels have curved buckets along which the water flows, and the reaction wheels have as their type a closed pipe from which the water discharges more or less tangentally. Pressure or impact, and reaction wheels are dissimilar to each other in construction. The essential difference between them being that in the two former, the cells or conduits between two adjacent buckets are not filled up by the water flowing through them, while in reaction wheels the section is quite filled. If the buckets of an impact wheel are given great length and form a hollow curve the water then not only impinges on the bucket but exerts a pressure on it, and the effect is claimed to be greater than in the purely impact wheel: the maximum effect is produced when the water falls dead from the wheel.

The theory of the reaction wheel is that the reaction is as great as the vertical impact of the water on a plane surface, and is claimed to be equal to the weight of a column of water, the basis of which is the area of the discharging orifice and whose height is double the height due to the velocity of the water discharged. The reaction wheel is more popularly known as the "Barker Wheel," and the most approved types are some form of what is known as the "Scotish Turbines." The outlets being generally two or three in number, made curved, with the introduction of a moveable piece at the outer orifice of the conduits by which the section is regulated.

The other distinctive type of motor, the piston, is some form of a water cylinder engine, the motion being reciprocating rectillinear and not rotary as in the jet or turbine, the leading feature being some form of a three-way cock, serving alternately to open and close the communication between the working cylinder and the pressure pipe. When the way is open the water presses on the piston and raises it with its load through a certain height, the length of stroke; when the communication between the pressure pipe and cylinder is shut, a way is opened for the discharge of the water from the cylinder and the piston descends by its own gravity. The piston water motors are generally made with a number of small cylinders, all connected up on one central shaft and are arranged so that when two or more cylinders are descending by gravity the others are doing work. The mechanical effect of water pressure or piston motors is evidently the number of strokes per minute and their length multiplied by the area of the working piston, multiplied by the effective head and its weight, divided by 33,000 for nominal H. P., multiplied by a co-efficient which shall represent the losses due to the friction of the piston, the friction of the water in the supply and discharge pipes, the diminished efficiency due to the changes in direction and sectional areas of the various pipes, loss due to the cocks or throttle valves and loss due to leakage of working parts.

Weisbach, Vol. 2, of edition of 1849, gives a very elaborate discussion and formulas to arrive at these various factors, and to which I refer for more detail data.

The various types of water motors now on the market may be generally described as follows :

The Tuerk Water Motor, manufactured at Chicago, New York City office, 237 Broadway.

This is a sample of the jet motor and is a combination of the impact and pressure wheel. Its economy is controlled by an automatic governor device. The device consists of a tapered or conical pointed valve stem, accurately adjusted to fit on ring nozzle, or bushing, by which the size of stream is increased or diminished in proportion as the point of the stem enters the bushing. This valve stem is made to enter into or recede in the bushing by the motion of the governor balls, being drawn in or thrown out as more or less water is required to perform work.

The Backus Motor, made at Newark, New Jersey, is another style of jet motor. They claim that the Backus should be called a pressure wheel, as it requires the impact and not the body of the water, and that it would run just as well with a jet of steam to drive it. This motor is also controlled by a governor and valve. Their controlling valve is, however, an angle valve, located in the supply pipe and seems to have no immediate connection with or regulating the area of the jet. The valve raises off or lowers to its seat as various amounts of water may be required.

The Syracuse motor, made at Fulton, New York, is another form. It is a reaction wheel. It has a shaft with power projectiles. It is a form of Barker wheel, but is of the Scottish turbine type, the pipes or conduits, or as they style the power projectile, are made curved and are two in number. The automatic governing feature is a movable piece at the outer orifice of the conduits by which its sectional area is regulated, the centrifugal motion of the reaction conduits or projectiles automati-

cally increasing or contracting the discharging orifices, as more or less speed, hence water, may be required.

The Pelton California Motor, made at San Francisco, Cal., is an example of an impact wheel. This machine may be generally described as follows: It is an undershot wheel, hanging clear of the tail water. The buckets are pockets similar to grain elevator carriers with a central septum or divison, the jet being arranged with reference to the septum so as to divide the jets as it strikes the bucket or pocket. The wheel and bucket having received the impact of the water, the water falls away on each side of the moving wheel, and the sides of the case are enlarged at this portion of its circumference so as to give a free exit to the water. The water is not carried along with the moving wheel scarcely any past the bottom center. The inlet water pipe enters at the base of the case. Provision is made for regulation by changing the tips of the jet. A hand hole plate being provided on side of case to reach and change it. Three sizes of tips are furnished with each machine and consumers are advised by the motor company to experiment with them. Using the smallest first and then the larger, if necessary, to give proper speed and power.

The Chandler & Silver Water Motor, made at Boston, Mass., is an example of the Piston or Water Cylinder Engine. It consists of five cylinders connected in one solid casting, and rotating upon one central shaft or axis, being arranged in such a manner that the flow of water is admitted in a continuous stream to one cylinder after another, where it impinges directly upon pistons working in said cylinders, and by means of connecting rods imparts a continuous rotary motion to a wheel set at right angles to the cylinder shaft. The valve motion is so adjusted that not less than two cylinders are always open to receive the water pressure, thus avoiding any dead center. The automatic controlling arrangement is a counter balance to the thrust of the pistons, arranged with a lever or weight on the side of the engine by which the stroke of the piston, hence quantity of water, is adjusted to the amount of work to be performed.

The Amherst Motor, made at Holyoke, Mass., is also a piston or water cylinder engine. The peculiarities of its construction consist in several pistons, eight in number, working very similar to the Chandler & Silver, but with no regulating device.

The Belknap Motor, made at Portland, Maine, is an example of a reaction wheel. The regulating device is a positive contraction and expansion of the discharge ends of the two arms by a piston gear. This gear is extended to the outside of motor to be operated, by lever, thus adjusting the water jets which are opened and closed at will by operating the two wedges which are affixed securely to the end of the lever which is operated by cog gears. Their claim is that the water wheel runs very closely to water chute, through which the water passing over wedges described, enters the wheel at a distance not exceeding one thirty-second of an inch, the water exerts its full force on the wheel nearer the orifice than of any other motor.

There are also a number of other motors made but not so generally advertised as those I have described. One is made at Oneida, N. Y., another at Binghamton, N. Y., one at Newport, N. Y., and one by Mr. Jas. Nailer, Jr., of Poughkeepsie, N, Y., and from what I can learn all these are either impact, pressure or reaction wheels.

Horse Power of Water.

The horse-power of water is the quantity used per minute, multiplied by the head under which it is operated, multiplied by the weight of the water, the product divided by 33,000 ft. pounds. This is the nominal horse-power of any machine or device by which power is obtained from water. The effective horse-power is a certain percentage of this. The large water turbines, used under low heads, produce from 60 to 85 per cent. of the nominal horse power. The small water motors, which are the subject of this article, realize from 40 to 60 per cent., dependent upon their construction.

Their economy in practical every day use is largely dependent on the sensitiveness of the adjustment by which the quantity of water used is adapted to the varying load or power required.

Water Motors at Little Falls.

I propose now to give a general statement of motors used, for what purpose, and the quantity of metered water for the year, in each establishment at Little Falls, N. Y., following up the same with a detail statement of the amount of water used per minute by various machines operated by water motors and obtained by tests, hoping that this detail information will form a more reliable basis than the simple statement of the total amount of water used for the year, as it has seemed to me that the metered water per minute required to operote a certain make and size of printing press, for instance, will form a reliable basis upon which to establish a probable consumption in any other locality. The head, or pressure, being given at the locality of the test, the variation in the amount of water used with a different head will be approximately proportional to the variation in the head. The lesser head requires more water.

D. H. Burrell & Co., Jobbers in Cheese Factory Supplies.

Water pressure, 120 lbs., 15 H. P., Tuerk Motor, used for operating a one-ton elevator and for buzz saw 12 inches in diameter: Consumption January 1, 1890, to January 1, 1891, 341,210 cubic feet, or 2,552,250 gallons, costing at Little Falls water rates, three cents per 1,000 gallons, $76.56 per annum. Metered water also used for drinking purposes and sprinkling street.

Journal and Courier Printing Office.

They have for the past year printed their weekly paper, and in addition the "Daily Herald" newspaper, as well as conducted an extensive job office. Water pressure 110 lbs., eight H. P. Tuerk Motor in use, running one Campbell cylinder, No. 2 Complete Press, and three platen job presses of the following sizes, one ½ medium Gordon, one ¼ medium Gordon, one ⅓ medium Gordon.

The Tuerk Motor took the place of an 8 H. P. engine and boiler costing with attendance, $2.00 per day to run, or $600 per year. Consumption of water January 1, 1890, to January 1, 1891, has been 426,910 cu. ft., or 3,193,286 gallons, meter measurement, costing at Little Falls water rates, three cents per 1,000 gallons, $95.79 per annum. This annual cost also includes water used for the general usages of a printing establishment, washing type, etc., as well as five water closets and

two urinals, domestic water for two families and Masonic Knight Templar rooms, all passing through meter.

DR. J. V. HEMSTREET, DENTAL ESTABLISHMENT.

Two operating dentists as also laboratory employees: water pressure, 90 lbs. One H. P. Tuerk Motor, running lathes and other required machinery in a first class dentist establishment.

Consumption of water January 1, 1890, to January 1, 1891, 11,522 cubic feet, or 86,184 gallons, meter measurement, costing at three cents per 1,000 gallons, $2.58 per annum. Metered water used exclusively for machinery.

W. R. CHAPPLE, "HERKIMER COUNTY NEWS.

This is a weekly paper and an extensive job office. Water pressure, 105 lbs; 4 H. P. Amherst Piston Motor, running one Campbell cylinder No. 3 Complete press, and two platen job presses. One Peerless Jobber, ½ medium, one Peerless Jobber, ⅛ medium, taking the place of a 5 H. P. engine and boiler, costing $1.00 per day, or $300 per year. Consumption of water January 1, 1890, to January 1, 1891, 145, 338 cubic feet, or 1,087,128 gallons, meter measurement, costing at Little Falls water rates, three cents per 1,000 gallons, $32.61 per annum. This amount also includes water for general uses, etc.

J. S. BARNET & BRO., CALFSKIN TANNERY.

This is probably the largest and most complete calfskin tannery in the United States. Water pressure 140 lbs., a 15 H. P. Tuerk Motor in use; operates a dirt extractor, exhaust fan machine for drying hair and a hair washing machine, doing the work of steam costing $5 per day or $1,500 per annum.

Consumption of water from January 1, 1890, to January 1, 1891, 1,998,990 cubic feet or 14,952,445 gallons, meter measurement, costing at Little Falls rates, $448.56 per annum.

In this case the water, after having been measured and used in the motor, is passed along to the vats and again used for general tanning purposes. This double use of the water practically makes the cost, either of the motor or for tannery purposes, nothing, just as it may be elected to call it. I think this double use of the water may be accomplished in other mechanical establishments and is suggestive as to possible economic results in other places.

F. L. SILLIMAN, TEA AND COFFEE STORE.

Water pressure, 95 lbs.; 2 H. P. Syracuse Motor, used for grinding coffee in a No. 18½ Enterprise Coffee Mill, Philadelphia make. Metered water not used for any other purpose. Consumption from January 1, 1890 to January 1, 1891, 44,296 cubic feet, or 331,334 gallons, costing at three cents per 1,000 gallons, Little Falls rates, $9.93 per annum.

F. FRANCISCO, BAKERY

Water pressure, 110 lbs.; used for ice cream freezer. Capacity ten gallons. 2 H. P. Tuerk Motor. Consumption from January 1, 1890 to January 1, 1891, 16,347 cubic feet or 122,275 gallons, costing at three cents per 1,000 gallons, $3.66 per annum.

Jno. R. Baker, Restaurant and Ice Cream Saloon.

Water pressure 110 lbs., used for a 7 gallon ice cream freezer and to operate 5 fans of the Kulp, Lancaster, Penn., make, 3 H. P. Tuerk Motor. Consumption January 1, 1890 to January 1, 1891, 164,251 cubic feet, or 1,228,597 gallons, costing $36.84 per annum. This consumption includes Restaurant and Bar uses.

Carden Brothers.

Water pressure 120 lbs. 1 H. P. Amherst Motor. Soda water and pop bottling establishment, one large Mathew's generator and fountain, size No. 151, two fountains. Consumption January 1, 1890, to January 1, 1891, 32,081 cubic feet or 239,965 gallons, costing at Little Falls rate, three cents per 1,000 gallons, $7.19 per annum. This also includes water used for washing purposes.

D. H. Burrell's Residence.

Pressure 90 lbs.; 6 H. P. California Pelton Motor, used for running dynamo, operating twenty-four 16-candle power electric lights. Consumption not determined by meter measurement, as the price for electric light water power is fixed by the Little Falls rates at $20 per annum for twenty-four 16-candle power lamps.

Test Measurements.

The test measurements show that the one ton elevator in D. H. Burrell & Co's establishment requires the following amount of water to operate: 2,000 lbs. load, raised and lowered, requires 50 cubic feet up and 10 cubic feet down. 1,000 lbs. load takes 33 cubic feet up and 20 cubic feet down. 500 lbs. load requires 28 cubic feet up and 22 cubic feet own. Elevator light, with one man on, uses 25 cubic feet up and 22 cubic feet down. The buzz saw uses from 13 to 16 cubic feet per minute sawing, the variation being due to different thicknesses of wood sawed. All the above loads were run 55 feet vertically, up and down.

From the tests made in the Journal & Courier office I find that the No. 2 Campbell Complete Press requires 3 $\frac{4}{10}$ cubic feet of water per minute to operate. The ½ medium Gordon Job Press, 2 cubic feet per minute. The ¼ medium Gordon Job Press, 1 $\frac{6}{10}$ cubic feet per minute. The ⅛ medium Gordon Job Press, 1 $\frac{2}{10}$ cubic feet per minute. When the presses, all four, are running at the same time they use 4 $\frac{4}{10}$ cubic feet per minute, and the three Gordon presses only, running together, require 2 $\frac{5}{10}$ cubic feet to operate. The advantage of an automatic regulation is apparent from the amount of water used.

The No. 3 Campbell Complete Printing Press in W. R. Chappel's Herkimer County News office, requires 4 $\frac{5}{10}$ cubic feet per minute to operate, and 4 $\frac{5}{10}$ cubic feet per minute running light, no forms on. The platen Job Presses in W. R. Chapple's office require as follows: The ½ medium Peerless 3 cubic feet per minute. The ¼ medium Peerless 3 cubic feet per minute. Both Job Presses running together 3 cubic feet per minute. The Campbell No. 3 and the two Peerless presses all running together 5 $\frac{5}{10}$ cubic feet per minute. These results show the loss due to the lack of a governing device.

The lathe in Dr. Hemstreet's Dental rooms requires one-half of a cubic foot per minute to operate.

The coffee mill in F. L. Stillman's store, which is an Enterprise, No. 18½, requires one cubic foot per minute to operate.

The Fans in John R. Baker's Restaurant require cubic feet per minute to run them. The 7 gallon ice cream freezer requires cubic feet per minute.

The washing machine in Barrett's tannery requires 8 cubic feet per minute. The whizzer or drying machine requires 6 cubic feet per minute to run, and both machines running together take 10 cubic feet per minute to operate.

The generator in the soda and pop bottling establishment of Carden Brothers requires one cubic foot per minute to operate.

The 10 gallon ice cream freezer in Francisco's store requires $2\frac{50}{100}$ cubic feet to operate.

It is but fair to state that in the case of Dr. Hemstreet's and the Silliman motors the supply main is too small, both being taken off of a single ¾ inch service. May 1, 1891, this will be remedied by changing to a 4 inch service and adding then to the same service the "Daily Times" newspaper, with a new Cottrell press, and with your permission a new test will be made and the correct amount of water due to the pressure, inserted in this paper, in the Annual Report of this Society, as well as amounts used in Baker's restaurant. He is not running now.

Economic Features.

The economic features of the use of water motors comprises more factors than simply the saving, as compared to the cost of steam and its necessary attendance. There is the constant availability of a water motor under full capacity at any minute, the immediate stoppage of all running expenses when the particular work in hand is completed. Take for instance a printing press in the ordinary newspaper or job office. Presses are rarely run constantly during the hours of work, but usually represent but a fraction of the time each day and at no exact recurring or particular time of day. The motor, however, is always ready at full capacity; it is like a water works system with hydrants, always ready at full pressure, as compared to the delays incident to getting up steam in the ordinary steam fire engine. There is also the immunity from danger from fire, hence less hazardous fire risk, the superior cleanliness as compared with steam, the absence of that intolerent heat in the working rooms during the summer season, besides many other little conveniences incident to the use of water motors, in place of steam. All these factors, however, may be said to inure to the benefit of the consumer, and not particularly to a water works plant, Let us now glance at the economic, or perhaps more exactly, the benefits derived by the water works plant, incident to the introduction of water motors. From my test measurements made of the actual consumption of water, I am satisfied that it is not desirable to connect up water motors where the working pressure is less than 50 to 60 lbs. to the square inch. When either a public or private plant is taxed up to near its full capacity for domestic consumption and an additional supply is an expensive addenda to procure, motors are out of the question; but when the pressure exceeds 50 to 60 lbs., and there is a surplus in excess of domestic uses, either in quantity of water by gravity systems, or capacity of machinery in pumping plants, water motors may be made a profitable adjunct at water rates as low as three

cents per 1,000 gallons. When rates, up to ten cents per 1,000 gallons, or upwards, are obtainable, all the receipts exceeding two or two and one-half cents per 1,000 gallons are profit. The actual cost of pumping and repairs of pumping machinery, it seems to me should represent the cost to the water works or company, not the addenda of fixed charges added; the fixed charges, interest, etc., accrue in any event whether more or less water is consumed. Any increaseed use of water paying any excess over and above the cost of pumping and repairs is just so much additional revenue that would not accrue unless the consumption was augmented by water motors or other uses not provided for, or prospective in domestic consumption; the fixed charges, however, accrue whether such water motors are inaugurated or not.

Again there is an increase of revenue, incident to but not directly exhibited in the water motor receipts.

The use of water motors makes many properties lying along the lines of a water works distribution system available for light manufacturing uses that were not previously so. Small industries may be profitably inaugurated in such localities in a town by the aid of water motors, making cheap property available for manufacturing purposes that would be prohibitory using steam, and expensive property where steam will not be allowed. Existing small industries may also be extended profitably by cheap water, good pressure and water motors. All these additional and increased uses increases the number of wage earners at good wages, and the addition of good wages and good mechanics guarantees an increased use for domestic purposes, and hence increased revenue on other lines than merely the revenue due primarily to water motors.

Increase in the population in any city or town may be said to be coincident with its increase in manufacturing interests; increase of population inures to the benefit of all water works systems, whether public or private, and as a sequence the use of water motors, with good pressure and cheap water, increasing the number and volume of manufacturing, it follows that their use must be a benefit and source of revenue, both in direct receipts from the same and a general increase due to increased population and prosperity.

There is one detail of construction that I desire to call attention to, and that is, not to use too small a feed pipe or lateral service from main. My experience tells me never to use less than a two inch lateral service in any case, and with all the larger sizes of motors to use a four inch cast iron service. The four inch service does not necessitate a special in the mains, but the following plan will fill the bill: Plug the end of the four inch service, lay the plugged end on top of distribution main, carry three or four inch taps by short lengths of inch lead pipe from main to service, spacing the inch taps fifteen inches apart, will prevent any undue weakening of the main. The two inch service I lay the same way, using two one inch taps and short lengths of inch lead connections. There is also an advantage in this plan, in that it takes up pretty much all the ram, if any occurs, banging away at the plug in the end, and does not affect the main.

In conclusion, thanking you gentlemen, for your attention, may I express the hope that this presentation of the subject may be of service to other members of this association.

STEPHEN E. BABCOCK, *Consulting Engineer*.

MARCH 27, 1891. LITTLE FALLS, N. Y.

THE PRESIDENT: I think, with me, gentlemen, you will all feel great satisfaction with this paper. Although omitted from our printed programme, we have not been prevented from hearing it. It contains a vast amount of information, which at one time in our experience we would have been very glad to have been in possession of. It is now before you for your criticism and discussion, and Mr. Babcock will doubtless be glad to answer any inquiries that may be made.

MR. CHASE: I would like to ask whether Mr. Babcock made any experiments as to horse-power; he speaks of motors rated at twelve to fifteen horse-power. It would be of interest to know just the horse-power he did get out of one of those motors.

MR. BABCOCK: The largest horse-power was 67½ per cent of the nominal horse-power of the water.

MR. CHASE: That is not actually the question—the actual power developed; how much water could you use, or how much horse-power work could you make out of it? For example: A motor that is rated at fifteen horse-power—we would like to know whether it was brought within eye-sight of that amount of power.

MR. BABCOCK: The motors have been tested up to 67½ per cent of the nominal horse-power of the amount of water used. My own judgment is that the best motors will run from 55 to 60 per cent. I have never had occasion to put on any device for testing the actual power used. It is quite an expensive affair, and it does seem to me, if it is important, that it would be well to have a committee of this Association to test a series of these motors with a dynamometer; but I gave my results from certain sizes of machinery. For instance, printing presses, described and technically known in the trade, on which the water motor was used—we know what it costs to run one of these printing presses. A man will tell you by looking at the class of press what amount of power will be required to run one of them. It will take considerable time to go through a test as to the actual horse-power, and it struck me that it would be far

more preferable to give the specific machinery run by the motors, rather than to give the horse-power of the motors.

MR. ALEXANDER: I would like to ask one question: I have had some experience with water motors myself. In the case of the Courier printing office it is stated that you placed an eight horse-power motor to replace an eight horse-power engine and boiler to run one Campbell cylinder No. 2, complete press, and three job presses of the following sizes: One $\frac{1}{8}$ Medium Gordon, one $\frac{1}{4}$ Medium Gordon and one $\frac{1}{2}$ Medium Gordon. Do you know whether either of them exerted eight horse-power?

MR. BABCOCK: The engine, do you mean?

MR. ALEXANDER: You say that the motor took the place of an eight horse-power steam engine.

MR. BABCOCK: I understood that they drove the steam engine to death.

MR. ALEXANDER: Have you any idea how long they run each day?

MR. BABCOCK: They run the daily newspaper every day for one year, which would perhaps take them, I should judge, an hour or so every day to run off an edition on a No. 3 Campbell cylinder press, and the three job presses, which were run off and on all day long. I have no method or means of timing them. I thought if I gave this data anybody knowing the printing presses would understand.

MR. ALEXANDER: Don't you think that $2\frac{1}{2}$ horse-power would done that work?

MR. BABCOCK: I question it very much indeed.

THE PRESIDENT: I would like to know whether your water supply was by gravity or pumped.

MR. BABCOCK: Gravity. We have two million gallons running to waste all the while.

MR. CHASE: Mr. Babcock has given us a very practical paper. Looking at it from a strictly professional point of view, I don't think he can make much of a

showing of the motor as an economical machine for developing power. I know of a case of an engine displaced by a water motor, and the parties claimed that they were using a four horse-power engine to run a printing press. While the motor was being substituted they run the press right up to its regular work by three men working at a crank, one changing off every five minutes, which is about all the work the motor did. Any engineer knows the value of man-power as compared with horse-power. In one case, Mr. Babcock says, a press used four feet of water, which on its fall I find gives about $2\frac{1}{4}$ horse-power; allowing 60 per cent for efficiency of motor, would show that the eight horse-power motor referred to was developing only about $1\frac{1}{4}$ horse-power. I was interested to learn if he really knew how much power he had actually got out of any motor.

Mr. Babcock: My object was not to give that specific information, as I thought it was not as desirable as the information I did give. Of course I could have put a dynamometer on and could have obtained the exact result.

Mr. Steben: I think that the question of water motors is one of great importance, especially for those who are interested in water works, and think we have a great deal to learn in reference to the economical benefit to be derived, as far as our water works are concerned, as to the use of water for power. I do not wish to hurt anybody's feelings or hurt the feelings of the makers of water motors. I have had a little experience in the last two years as to the quantity of water required for motor purposes, and I must confess that we have been somewhat afraid to put in more motors, for the reason that they use a great deal more water than represented to produce a certain amount of power, and I think there is only one remedy for this question—to have a test of the different motors made by experienced men.

We know it is quite natural for any manufacturers to praise their goods to the highest standard, but when the question arises whether it is to the interests of the water company to supply water for motor purposes, I think that I can safely say that we are at a loss to know whether it is to the interests of the company to supply

the water and keep the extra pressure which is generally required to satisfy customers, in order to give them enough pressure to do their work with the motor. As I stated before, the question of water motors is a very important one, and I think there is nothing of more importance before the Association than the use of water motors, and the question is one which ought to be investigated very carefully by every member of the Association, and perhaps it would be advisable that a committee be appointed to make a test of the different motors. If the Association thinks proper, I would suggest that a committee be appointed by our worthy President to test the different motors as to power and the quantity of water used for same, etc., and report at a future time.

I might state that at Brockville we have a very good water supply. Domestic pressure is 65 to 70, and fire pressure 75 to 85, and there is a good opening for water motors, if we could only learn a little more about the benefit derived from them in as far as the water company is concerned.

Mr. Milne: I do not think, gentlemen, that the difficulty lies so much in the principle of the construction of the water motor as it does in the application of that principle. There are so many different motors in use. Mr. Babcock in his paper takes a very wide range. Now, surely, the same consideration should be given to the hydraulic motor as to any other class of machinery. Some of our engine builders say the nominal horse-power is so much and the indicated horse-power is so much. That is due to variable conditions, and in the case of the hydraulic application of power it brings me back to the consideration of the question as I presented it yesterday. It must be a constant factor of pressure and must be preserved as going to the constant expression of power for any hydraulic machinery. Therefore the necessity and importance is applicable to one system because you are very apt to blame the hydraulic motor when the blame should be put on the pressure, which is variously maintained during different hours of the day and by different plans of distribution. If it is possible to maintain a constant pressure under all conditions of distribution, then it is certainly possible to get the best results

out of any motor according to its class, kind or character. This is apparent to the mind of any reasonable man in this room. There is no mistake about the mechanical relation of hydraulic power, from the fact that when you cease using it you cease using everything else. It is not like steam; you shut down the steam and bank your fires; but there is still a consumption of coal—a very considerable consumption—so that after all, when you analyze the relative cost of running a hydraulic motor and a steam engine, you will find the hydraulic motor is very much more economical.

Mr. Denman: Mr. Chairman, I do not know much about the science of this thing. I cannot discuss it very well, but I have tried to encourage the adoption of water motors in our city. On one or two occasions we have coaxed people to use them for experimental purposes. I have said a hundred times, perhaps oftener, to gentlemen who inquired of me about motors for mechanical purposes, that I would give them the water for one month, or two months, or six months, if they would conduct experiments as to the economy. It was tried on one printing press at a ruinous rate. I do not know what the style of the motor was, and I would not say if I did. We have tried it in our telephone exchange and the cost there has been out of all proportion. I am one of those who believe in making water works earn the greatest amount of money consistent with safety, and I should very gladly adopt some motor or some system to encourage the use of motors, if it could be done with any sort of economy to the consumer, or if the water company could get Little Falls prices for the water. By the way, if we had to take the Little Falls prices for water, many of us would think it a mighty big fall. [Laughter.]

Mr. Babcock: It is a pretty big fall—about five hundred feet head of water. In the use of motors regard should be had to the frictional action of the water. My theory of putting in a motor is so that there is no loss at all due practically from the friction in the mains.

Mr. Denman: If we should undertake to put in an inch connection for every motor used, as suggested here, it would scare us.

MR. BABCOCK: It does not need any more than three-fourths inch pipe.

MR. DENMAN: There is a relation between demand and supply.

MR. BABCOCK: It is not the passage of the water through the pipe; it is the pressure, the frictional loss of the water passing through the main. If you get a main so large there is no loss due to the friction, then you get the full benefit of your head, and there is the great trouble with most motors. They put in too small size and do not get economical results in the use of the motor.

MR. DENMAN: I took the trouble of getting at data in regard to this matter. It was said that certain newspapers were run at such a price per annum. Now, the fact was that the water company did not know anything about the quantity of water they were furnishing to the newspaper companies who own the motors, and the newspaper companies had no conception of the quantity they were getting. If I could put on a motor and furnish my house with electric light I would be willing to pay seven or eight times as much as Mr. Burroughs pays for his residence.

MR. BABCOCK: I presume you would get it for less.

MR. DENMAN: That would be $150.

MR. BABCOCK: I desire to say that I have no interest in motors in any shape or form, and I have been discussing the various classes of motors for the benefit of the Association, but there are a great many people who really do not know the characteristics of the different classes of motors. I have been so situated that I have had a chance to examine nearly every class of motor in use, and have taken considerable pains to do so and to see how they were made.

MR. DENMAN: The illustration of the Journal and Courier printing office interests me. It is stated that $95 and $75 was the cost per annum at three cents per thousand gallons. Now, our rate would be twenty cents per thousand gallons, and we have not got a newspaper

in our town that would not be willing or glad to pay the water works the amount which they pay at Little Falls for the same duty.

THE PRESIDENT: What is your pressure?

MR. DENMAN: We carry a domestic pressure of ninety to a hundred pounds. I would be very glad if this thing could be demonstrated so that we could adopt the recommendation of the paper.

MR. BABCOCK: The test measurements were made with a stop watch and were recorded accurately. It seems to me it would be a very good thing if this Association could appoint a committee to make comparative tests of the different motors or different classes of machinery run by them, putting on a dynamometer to determine the horse-power used by the various machines, and in that way they could learn something about it. It is a big undertaking, and there is no member of the Association who would care to do it, because there is nothing in particular to be gained by it personally.

MR. MARSH: I would like to say a word in reply to Mr. Denman. I represent a water motor company. I would say that the facts given by Mr. Babcock are interesting to myself. We put most of those water motors in at Little Falls, and if Mr. Denman would like to have it demonstrated at his own works or at any printing office, we should be only too glad to demonstrate it. I think we can amply justify anything represented by Mr. Babcock's paper. I think I might mention in that respect that most of the motors that we have been putting in have been tested by Mr. Babcock, a fact which was quite unknown to us. We usually put in a water motor for a printing press, and it is left there to the care and management of those in the office, and they run the motor in a very indifferent kind of a manner, and they allow the water to go racing through sometimes without regard to the best economy in the working of the motor. I would just state to Mr. Denman that we would be glad to submit a motor to the use of his people.

THE PRESIDENT: We will now pass from this subject to a paper by Dr. Leffman on the purification of water by means of metalic iron.

THE PURIFICATION OF WATER BY METALLIC IRON.

BY HENRY LEFFMANN, OF PHILADELPHIA.

Mr. President and Members of the American Water Works Association:

My purpose in the present contribution is to briefly explain and demonstrate the efficiency of a simple process of purifying water. Of the value of such process it is not necessary to speak. Not only do the requirements of sanitation demand pure water, but many manufacturing industries cannot be carried on without such supply. It will not be necessary for me to detain you with the history of the process, except to say that it originated in an effort to improve the water supply of the city of Antwerp, about six years ago, at which point the only supply available to the company which had secured the franchise was a river very turbid and impure. The success of the system on a large scale for the past six years at Antwerp, and for shorter periods at other places, has been attested by the reports of experts and the statements of impartial observers, among the latter being a member of the State Board of Health of Pennsylvania and a member of the Board of Trade of this city. The practical process may be explained as follows:

Metallic iron, in the form of either cast iron borings or steel punchings, is placed in a cylinder so arranged that by a slow rotation the iron may be continuously showered through the water, which is being passed at moderate speed through the same cylinder. The cylinder is provided with pipes by which air may be introduced in direct contact with the iron, if necessary. The chemical action consists in great part in the conversion of the iron into ferrous carbonate (protocarbonate of iron) through the agency of the carbonic acid, which partly dissolves in the water and partly remains suspended in the form of dark green turbidity. On exposure to the air the iron is converted into ferric hydroxide, (hydrated sesquioxide of iron), which, settling rapidly, carries down with it and oxidizes the organic matter. The flocculent sediment permits of rapid and perfect filtration through a simple sand filter.

The process may be carried out in the laboratory in such a manner as to exhibit results as they would be obtained in the actual treatment. It has thus been possible to examine the behavior of waters of different types and to determine the most satisfactory system of application.

A process of this kind, essentially simple, does not require for its correct presentation an elaborate discussion of the theories of the action. For evidence of its efficiency I think I can best point to the continued successful application of it to the purification of the waters of Antwerp, Dordrecht, Paris, Nancy and other places.

The advantages of the Anderson process, as this method is called, over other methods of purification and filtration, are, among others:

1. The avoidance of the use of chemicals.

Far from exciting prejudice, the idea of putting rusting iron in contact with drinking water is one that has been familiar to the public mind from time immemorial. Scientifically utilized, as in the Anderson process, metallic iron, by its mere contact with impure water, produces, by the help of the ingredients of the water, the salt necessary to produce purification. Natural oxidation causes this salt to act as a coagulant, and further, the action of the ferric oxide, or rust in its nascent state,

furnishes the power of destroying organic matter by a process which has been likened to the burning of holes in linen by rust stains or iron mould.

2. The automatic and continuous renewal of the active surface of the iron.

By means of the Revolving Purifier system, (the technical name for the process), the various forms of iron previously recognized as efficient purifiers of water can be utilized without incurring the mechanical difficulties resulting from their use in filters, which become choked up and caked after a short time.

The iron being in a constant state of agitation no choking or caking together of the purifying medium is possible. The particles of the finely divided metal are kept rubbing against one another, and new surfaces are brought into contact with the water, which in its flow carries out of the cylinder the iron which has been dissolved by chemical action with the impurities contained in the water. Owing to the completeness of the contact between the iron and the water and the large surface of metal exposed, purification is effected in a space of time of 3½ to 5 minutes for moderately bad water and in 5 to 15 minutes for sewage effluents.

Again, it is evident that any purifying material spread out in a filter is constantly reducing the area of its active surface by the formation of the compounds which it makes in removing the dissolved impurities of the liquid it is filtering. The degree of purification effected must, therefore, constantly decrease until steps are taken to remove the products of the purifying action and revivify the purifying material. This has always been one of the greatest difficulties encountered when endeavoring to purify water or sewage on any scale of greater magnitude than that of a laboratory experiment or of a domestic filter. The Revolving Purifier entirely overcomes this difficulty by the constant rubbing together of the particles of the purifying material and the carrying away by the liquid itself of what we may generally term the products of the purification.

3. The removal of micro-organisms to such an extent that the water as delivered is practically sterile.

This extraordinary fact is conclusively proved by the experiments made at Antwerp by Prof. Van Ermengem on samples drawn at frequent intervals from the delivery pipes of the sand filters when supplying over two million gallons per day. The 100,000 microbe colonies contained in a cubic centimeter of the Nethe water are reduced to an average of five colonies, which, considering the great difficulty of avoiding all contact with the air in these delicate tests, is equivalent to a complete destruction of the micro-organisms.

The observations show that the process is applicable to the purification of all classes of natural waters. Waters turbid from suspended clay or sand, or colored by vegetable matters, are especially susceptible of rapid and complete clarification by it. In all cases chemical tests of the treated water show marked diminution in the organic matter, and the filtered water is practically sterile.

The following are the results of experiments on certain typical waters. (Specimens illustrative of these results were shown.)

A sample of water from Wilmington, N. C., strongly colored by dis-

solved organic matter, but not very turbid, was treated and the oxidizable matter determined. The results were as follows:

	Before treatment.	After treatment.
Oxygen absorbed at 212 F..... ...	14.20	2.44

The filtrate was clear and colorless.

The efficiency of the process in its application to turbid river waters is well shown in the experiment on the Mississippi water. This contained much suspended matter, which after many days standing did not perfectly settle, and could not be filtered clear. Treatment in the laboratory by the iron process gave results that were most satisfactory. After shaking with the iron and aerating by standing for a few minutes in an open vessel, the ferric hydroxide separated in large flakes, which permitted of prompt and rapid filtration, yielding a perfectly clear filtrate. To determine the degree of chemical purification, the oxidizable organic matter was determined as follows:

	Before treatment.	After treatment.
Oxygen absorbed at 212 F.....	2.88	0.36

In conclusion, I may say that since this method is best understood by observing its operation, I have arranged to show experiments on samples of various kinds of water, which experiments will be performed after the adjournment of the meeting.

THE SECRETARY: How long did it take that to settle after treatment?

DR. LEFFMAN: It took about until the next day. You will find on page 13 of the pamphlet the final report of the special chemical commission on the quality of the water supplied to Antwerp during the year 1889. (See pamphlet page 13.) You will find towards the bottom of the page the results of the bacteriological examination which corroborated these two chemical analyses. I think the exposition of this process can be best brought out by a discussion of it. I feel that addressing as I do practical engineers I am very apt to run off into matters that would not concern those to whom I am speaking. I would be glad to have the meeting discuss the question and would be glad to answer any question.

MR. DECKER: I would like to ask a question, what the effects are on hard waters, such as those which are charged with calcium sulphate, say to the extent of 20 or 30 grains.

DR. LEFFMAN: I do not think it would effect the calcium or magnesium sulphate owing to the fact that

the iron does not attack these, but waters temporarily hard are softened owing to the fact that the carbonic acid is taken up by the iron, as the solution of the carbonates is due to the carbonic acid. It is equivalent to the addition of alum which softens the waters temporarily hard but not waters permanently hard. Acid waters are improved. This is seen in the acid dissolved in Sheffield waters. There is a trace of acid in the water and it has been a great trouble, causing lead poisoning. It was found those waters were materially improved by the iron treatment, the iron neutralizing the acid and rendering its action on lead pipe less destructive and injurious taking up the acid which caused the lead poisoning.

THE SECRETARY: How long has that Mississippi water stood after treatment. That is to say, could that be so treated and allowed to settle and without any further filtration be used?

DR. LEFFMAN: I think it could.

A MEMBER: Is it separated by the iron?

DR. LEFFMAN: The analysis shows that the iron is no longer in the water. As to the economy the of system that is rather an engineering question.

THE SECRETARY: I ask the question because I read Mr. Devonshire's paper, read before the Franklin Institute in which he described the process. The water was first coagulated by this process and was then filtrated with the old sand filter—the idea was whether the water could not be allowed to settle and then used used without filtration.

MR. DEVONSHIRE: I would like to say a few words on this subject. The origin of the Anderson process of purification is as follows. The Antwerp water works originally constructed filtered beds containing spongy-iron, which was mixed with three times its bulk of gravel and arranged in a filter bed. The water percolated through this filtering material; the iron being taken up by the water and afterwards precipitated; and the precipitate being removed by sand filtration. The chemical effect of the use of spongy iron was all that could have been desired; the very foul water of the river Nethe,

from which the supply is drawn, being changed into a potable water of irreproachable quality. For some time the spongy-iron promised to satisfy all requirements, and to prove a satisfactory method of purifying the water on a large scale. After running the filters for some eighteen months, it was found that the filtering material had become rusted and caked together into an almost impervious mass, so that the water could not pass through in sufficient quantities to meet the demands of the city. Several of the most eminent authorities in Europe were consulted with a view of suggesting remedies for this trouble. One of them, Sir Frederick Abell, suggested that it was, in his opinion, necessary to devise some method by which the spongy-iron should be constantly kept in movement, and so prevent it from sticking together. William Anderson devised a method of accomplishing this, which is known as "The Revolving Puifier Process." Anderson started from exactly the opposite point from that at which all ordinary filtration had before that begun. He adopted, as the principle of his purifier, the showering of a small quantity of purifying material through a stream of water, instead of allowing a comparatively small quantity of water to percolate through a large mass of purifying material as in filter beds.

The revolving purifying process is not equally applicable to all waters alike. At all events, it is more easily applied to some than to others; and the cost of working the process depends upon the facility of its application in any particular case. The iron acts as a coagulum as far as the suspended matter of the water is concerned; and the desideratum in using it as a coagulum is to make the coarsest possible precipitate in the shortest time.

Water like that of the Mississippi or other streams which carry large volumes of clay substances, when in contact with scrap iron, produce a very coarse precipitate. The removal of this precipitate by straining in a filter becomes very easy. The filter may be worked at a rapid rate and for a long period without its pores being closed up. In other cases, such as at Antwerp or with the Delaware water, the precipitate formed is very much finer; and to remove it, under the conditions lain down,

in order to insure satisfactory chemical results, slow filtration must be resorted to. The authors of the revolving purifying process have laid down the law that the speed at which the precipitated iron is to be removed must be limited by the power of the sand filter to retain the precipitate at its surface. It is found, in practice, that the process is both more economical and efficient when the speed of filtration is limited to a rate which will allow of the whole of the precipitated matter being retained on the top of the sand bed and never allowed to penetrate into its mass.

The sand filters at Antwerp have been working in conjuction with the revolving purifiers since 1885. These filters have never been disturbed below their suface; and at the present time the sand in them is in an absolutely pure condition. Filter cleaning is accomplished by skimming off the thin film of the precipitate, which is arrested at the surface of the sand. I am of opinion that, to ensure a constant and unvarying chemical improvement in any water, it is necessary that this law should be strictly observed.

In answer to the questions propounded by Mr. Diven and President Bull, as to the cost of the Anderson process, I quote from a report made to the Franklin Institute of Philadelphia, in which figures are given as received from the managers of the Antwerp Water Works and the Dortrecht Water Works. At Antwerp the total cost, including sand filtration, supervision, iron required for purification, water for cleaning the sand removed from the surface of the filter, etc., is $2.50 per million gallons. At Dortrecht (where the water purified contains clay) the cost is given as $1.04 per million gallons. This difference in cost is due to the fact that at Dortrecht it is possible to use less iron than at Antwerp; the cost of the iron at Dortrecht being seven cents as against ten cents at Antwerp per million gallons, and that the Antwerp filter beds (originally constructed for the spongy-iron process) are unnecessarily large and not so economically cleaned.

As to the use of settling reservoirs in conjunction with this process, it may be possible, especially with waters of the nature of the Mississippi water, to avoid the use of filtration entirely by allowing the precipitated

oxide of iron to fall to the bottom of the reservoir by its own weight. But it is a question whether it is economical to construct reservoirs of sufficient capacity to allow the time necessary for the full settlement of the precipitate, when the last and finest portions of the precipitate are so very easily removed by sand filtration. The desirability of using the settling reservoirs and decreasing the size of the filters or of using filter beds only, without reservoirs, is one that must be settled by experiment on the particular water under treatment. There is no doubt that the highest efficiency of any filter is obtained when that filter is given the least possible to do; and I think the ideal, as far as economical work is concerned, would be their entire absence. Generally speaking, the location of water works for city supply is at a point distant from the densely populated districts, where land is inexpensive; so that the question of the space required for the open filter-bed system is one of little importance. If it can be shown that, in spite of their large area, open filter beds used in conjunction with the Anderson purifiers are very little, if any, more costly than the small high pressure system, and that the working cost of the process is considerably less, any objections to the process on the score of cost disappear.

Mr. Harlow stated that he had before him a report of the water works at Atlanta, Ga., in which he found that the action of the alum process in use there was $3.85 per million gallons last year.

THE PRESIDENT: Is John M. Diven present?

MR. DIVEN: My paper is in a very crude form and as our time is getting very short I think I will postpone it and try to get it in shape and put it in the proceedings. If we had been short of material I would have read it as it is, but I think it would be better to postpone it. And I move that we proceed to the business of the afternoon meeting. On this drive on which we start at two

NOTE.--After the adjournment of the meeting Mr. Devonshire and Dr. Leffman gave some demonstrations of the action of the process of water of different kinds, these including a sample of Mississippi water from New Orleans, containing a large quantity of clay mud, and also a sample from Wilmington, N. C., which was of the general nature of peaty or swamp waters. The effect of agitating a small quantity of cast iron borings in each of these waters, in a bottle, was to form a coarse precipitate which settled rapidly, leaving the water clear after standing a few hours.

o'clock there will be a luncheon served and we don't need to eat anything before we go. I move now that we proceed to the next order of business, the selection of the place of meeting and election of officers, and finish our business now, so we will not need to meet again.

Motion seconded and carried.

On motion, the report of the Committee on Nominations was received.

Mr. Gardner: Mr. President and Gentlemen—The Committee on Nominations for Officers of the American Water Works Association beg leave to recommend the following named persons to serve the Association for the ensuing year:

For President—J. M. Diven, Elmira, N. Y.
For Vice-Presidents—G. H. Benzenberg, Milwaukee, Wis.
—John L. Ogden, Philadelphia, Pa.
—Jos. A. Bond, Wilmington, Del.
—H. G. Holden, Nashua, N. H.
—W. G. Richards, Atlanta, Ga.
For Secretary and Treasurer—J. H. Decker, Salina, Kan.
For Finance Committee—Jas. P. Donahue, Davenport, Ia.
—Wm. Molis, Muscatine, Ia.
—Wm. Ryle, Paterson, N. J.

On motion, the report was adopted and the officers were declared elected.

The President: It has been customary, I believe, to appoint a committee to conduct the recently elected members to their official positions. I don't know whether it is the desire of the Association to have the committee appointed to move Brother Diven from that chair to this. I think that we might dispense with the committee and I will do it myself.

In resigning this badge of office I desire to express my thanks most cordially and most sincerely for the considerate and kind treatment which you have given me while I have filled this chair.

Mr. Diven: Gentlemen of the American Water Works Association—This is a total surprise to me and I find myself unprepared to properly thank you for the great honor you have conferred upon me. I have, from

my two years service as Secretary, got to consider myself one of the working force of the Association, and did not expect to be advanced to the post of honor—a position which I am almost ashamed to accept—following the dignified and graceful bearing of Mr. Bull. The only real qualification for the office that I possess is a sincere and disinterested desire for the success of the Association, and I will do everything in my power to contribute to that success.

THE PRESIDENT: The next order of business is the selection of the place for holding our next annual convention, and nominations are now in order.

THE SECRETARY: Mr. President, I nominate Indianapolis, Indiana. I have some most cordial invitations from there, which I wish to offer in support of the nomition.

Communications read.

INDIANAPOLIS, April 14, 1891.

J. M. Diven, Esq., Secretary American Water Works Association, Continental Hotel, Philadelphia, Pa.:

DEAR SIR—The Board of Trade sends by wire to-day a cordial invitation and will give up its beautiful hall and rooms for use of convention.

Have assurances from our best hotels that they will have ample accommodations and they will make satisfactory rates for the members and friends. No hotels better than ours west of the mountains.

Will depend on you to wire the convention for Indianapolis.

Yours truly,

F. A. W. DAVIS,
Vice-President and Superintendent.

INDIANAPOLIS, April 14, 1891.

J. M. Diven, Esq., Secretary American Water Works Association, care Continental Hotel, Philadelphia, Pa.:

DEAR SIR: In confirmation of telegram sent you to-day by Mr. Geo. G. Tanner, President of our Board, I am directed to extend to your honorable body a cordial invitation to hold its next annual convention in the city of Indianapolis.

The rooms of our Board of Trade are ample for the accommodation of your organization and they will be at your service.

Our hotel accommodations are first class and rates reasonable.

The National Brick Manufacturers' Association did us the honor to meet in our rooms January last, and we shall be pleased to have your Association accept our hospitality.

Yours very respectfully,

JACOB W. SMITH, Secretary.

INDIANAPOLIS, Ind., April 14, 1891.

J. M. Diven, Secretary American Water Works Association, care Continental Hotel:

The Indianapolis Board of Trade extends a cordial invitation to your order to hold its next annual convention here, and free use of our Exchange Hall and rooms for your meetings. Our hotel accommodations first class and charges reasonable.

GEO. G. TANNER, President.

MR. BENZENBERG: I do not rise to nominate any other city, but would suggest to the Association before they determine upon the next place of meeting, that by resolution or in some other way they should determine that they do not desire to be the recipients of so many courtesies, invitations and kindnesses as have been showered upon the Association at this place. I offer the following resolution:

Resolved, That this Association hereafter will respectfully decline to receive the courtesies of whatever place may be selected for the next convention to the extent of a banquet or other expensive entertainments, and to limit the encroaching upon the time of the Association so that there will be not less than three days for deliberation and business, and that the Association furnish its own banquet if they think best to have one.

MR. DECKER: I am heartily in accord with the spirit of this resolution, but would ask Mr. Benzenberg to so change it as to not bar out the exhibition of the public works and other objects of local interest and pride which I presume every city will want to show us.

MR. BENZENBERG: I did not mean that, because they are of great interest to every member of the Association. I meant to eliminate the expensive entertainment of a banquet.

MR. DECKER: I second the resolution.

MR. DENMAN: In my view we are standing on very delicate ground. I don't think the resolution ought to be passed. I make a motion that this matter be laid on the table and referred to a proper committee.

THE SECRETARY: Will you give me one chance before than motion is put?

MR. DENMAN: Certainly.

THE PRESIDENT: Mr. Diven has the floor.

MR. DIVEN: I make this as a substitute for Mr. Benzenberg's motion:

Resolved, That an annual banquet, to be arranged by a committee appointed by the President for that purpose, the expense thereof to be borne by the members attending, be a feature of our annual conventions.

MR. DENMAN: I don't wish to go to a banquet by law. I want to go to a banquet because it is convenient and because it is pleasant, not because it is necessary. I move that this matter be laid on the table.

A division was called for on the motion to lay on the table, resulting in 34 ayes and 18 nays.

The motion to lay on the table was therefore carried.

MR. FISH: I offer the following resolution:

Resolved, That the Committee of Arrangements accept no invitations that will interfere with three solid days' work of the Convention.

On motion the resolution was adopted.

Invitations were then extended by Mr. Fish to visit Chattanooga, and by Mr. Kelley to visit New York; invitations were also extended to visit Davenport, Ia., Scranton, Pa., Atlanta, Ga., and Minneapolis, Minn.

A motion was made that the first vote be informal, and that the two places receiving the highest number of votes on the informal ballot be formally balloted for.

Carried.

The informal ballot resulted as follows:

Chattanooga 8, Indianapolis 13, Scranton 2, New York 33, Davenport 4, Atlanta 1, and "Kelley's Island" 1.

MR. DENMAN: I move that the Secretary be instructed to cast the vote of the Association for New York as the next place of meeting.

This motion was agreed to and the Secretary was instructed to vote for New York.

THE PRESIDENT: Is there any other business before the Convention?

THE SECRETARY: I have two applications for active membership: P. D. Wanner, President Windsor, Pa., Water Works Co., and Dr. Henry Leffmann, of Philadelphia, Pa.

On motion the rules were suspended and the Secretary directed to cast the vote of the Convention for the applicants.

THE SECRETARY: Carriages will be at the Ninth street entrance promptly at 2 o'clock for the drive this afternoon. Lunch will be served at the Mansion House. For the trip to Camden and Atlantic City the boat will leave the Market street Ferry at 9 o'clock a. m. The ferry is at the foot of Market street, about ten minutes walk from the hotel. Cable cars on Market street will take you to the ferry. I have tickets here for all who have not already received them. I am requested to announce that "The Ancient and Honorable Order of '71,' I knowing it to be such," will hold a secret session in room 20 this evening.

I have two communications which have in some way been neglected.

PHILADELPHIA, April 14, 1891.

Mr. John L. Ogden, Chairman Local Committee American Water Works Association:

MY DEAR SIR—I beg to extend, through you, to the members of the American Water Works Association the use of the Reading Room and Library of this Institute during their stay in Philadelphia, and beg you also to state that should any of the members wish to attend the stated monthly meeting to be held in the hall (15 South 7th St.) on Wednesday, April 15th, at 8 p. m., they will be cordially welcome. Regretting my inability to take any active part in the work of your committee, believe me, dear brother, Yours sincerely,

WM. H. WAHL, Secretary.

PHILADELPHIA, April 15, 1891.

J. M. Diven, Esq., Secretary American Water Works Association, Continental Hotel, Philadelphia:

DEAR SIR—We respectfully invite the members of the American Water Works Association, now assembled in their eleventh annual convention, to see and examine a Riehle Transverse Testing Machine of 5,000 pounds capacity and as referred to and illustrated in the enclosed special circular, which is now on exhibition in Sample Room "A."

The importance of testing specimens of cast iron by transverse strains was referred to in the able paper read by Mr. T. W. Yardley, Esq., of Chicago, yesterday, before the Convention.

Our engineer, Mr. J. R. Matlack, Jr., who is well known to many of your members, is in charge of the Transverse Testing Machine and will be pleased to show it to those who may honor us with a visit.

We have on exhibition and in operation a Tensile Testing Machine of 50,000 pounds capacity at our factory, Ninth street above Master, and

would be glad to show it to those who may call and see it. The factory is a fifteen minutes ride in the cars running northward from Ninth and Market.

Enclosed is a circular showing a machine of the same style as the 50,000 pounds. We would be much gratified to receive a visit at our works and believe that is will prove of interest to you.

Very respectfully.

RIEHLE BROS.

THE PRESIDENT: If there is no other business the Convention will adjourn till Friday evening, the 17th, at 8 o'clock.

VOLUNTEER PAPERS.

The following papers were received too late to be put on the programme and so, though not unsolicited, are classed as *volunteer papers*. They were examined by the Executive Committee, who recommended that they be printed printed as a part of the proceedings of this convention, and the recommendation of the committee was on motion approved by the convention.

THE VERSAILLES WATER SUPPLY.

BY J. T. FANNING.

Member of the American Water Works Association.

The fountains of Versailles are among the chief objects of interest in the environs of Paris. A brief sketch of their water supplies in the past and present may interest members of the American Water Works Association who have not inspected them as they now remain.

The fountains had their origin a little more than two centuries ago, when Louis XIV, of France, was regally ascending toward the zenith of his power and his ambitious plans included a palace and garden surpassing in extent and magnificence those of contemporary monarchs.

The chateau completed by Louis XIII, of considerable magnitude and elegance, situated about ten miles southwest of Paris, offered a promising nucleus for the proposed more extended structure.

With the aid of Mausart, as architect, who planned extensive wing additions to the chateau, and of LeNotre, as landscape gardener, Louis XIV employed, according to the record, thirty-six thousand men and six thousand horses in the execution of works of his palace and gardnas and their accessories.

For the palace and fountains a great and continuous flow of water must necessarily be provided, as will be inferred when it is observed that the present garden facade of the palace has a length of thirteen hundred

and sixty-eight feet, or more than one-quarter of a mile, and the fountains rank among works of art as the great geysers of the Yellowstone Park among sublime works of nature.

The original project of this water supply was entrusted to Vauban, the most eminent engineer of his day. He proposed to bring the clear waters of the river Eure, by gravity, from a point thirty-one miles distant from Versailles, and his aqueduct exceeded in capacity the largest at Rome. The conduit, where open, was seven and one-half feet wide and four and one-quarter feet deep, and had a slope of 1 in 1,300.

In the line constructed there were, beside tunnels and open cuts, two hundred and forty-two arcades, containing in all seven hundred and twenty-six arches. One of these arcades is forty-four hundred feet long and has a maximum height of two hundred feet.

It is recorded that twenty-two million francs had been expended during the four years of labor on this aqueduct when in 1688, the work being still unfinished, a great mortality among the soldiers and workmen employed, caused a cessation of construction. The breaking out of war soon after prevented resumption of the works.

When, after some years, the water supply project was again taken in hand, the necessity of a prompt supply led to the adoption of a new and nearer source. This change involved the adoption of a bold hydraulic pumping project.

The river Seine, flowing westward from Paris, and northerly of Versailles, makes three great bends, forming a letter S. The third bend approaches, at Marly, within about five miles of Versailles, and between the second and third bends are a series of islands extending in the river several miles in their combined length.

A dam was constructed across the Seine im the third bend and the channel on southerly side of the islands converted into a water power, with a fall of eight to ten feet, varying according to the stage of the stream.

At this power were placed fourteen under-shot water wheels, each thirty-eight feet in diameter, ponderous constructions of wood and iron. These wheels operated two hundred and twenty-eight pumps, which forced water up a steep inclineon to the Marly plateau southerly of the river, to an elevation of five hundredfeet above the level of the pumps.

At the head of the incline the water was received in the conduit of a fine masonry arcade and conveyed from thence by an aqueduct to Versailles. This arcade is eighty-two feet in height at the head of the incline and extends two thousand one hundred and thirteen feet in length toward the high land of the plateau.

The piers of this arcade have cut stone quoins and the arches cut voussoirs, and the fillings of the piers and face walls are of ruble masonry, all at present in a tolerable state of preservation. In addition to this arcade of Marly, there is in the line another considerable arcade at Roquencourt.

These arcades are a single story in height, and the durability of their masonries has been well proved by the test of two centuries of weather beating. If, however, we compare these masonries with that of the older Roman work in the greater three-storied queduct of Niemes, in the south of France, we find the latter to be more massive in its arch masonries and much finer cut in its arch joints. Likewise, the masonries of the

Marly arcades are much inferior in workmanship to that of the three-storied aqueduct arcade over the river Arc at Roquefavour, which has a length of twelve hundred and eighty-seven feet and extreme height of two hundred and forty-two feet, and is now conveying water to the city of Marseilles.

The ponderous hydraulic machinery at Marly continued to supply the fountains at Versailles until the year 1855, but in the meantime, the water of the Seine not continuing of sufficient purity for use in the palace, an additional water supply was secured from the ponds in the high grounds westerly of Versailles.

By the year 1855 a reconstruction of the dam and machinery became necessary. A substantial masonry dam then replaced the old structure and a new pump house received six under-shot water wheels of iron, each of thirty-eight feet diameter with buckets of fifteen feet length. These six water wheels are set with their axles in line and on each end of each wheel shaft is a crank.

Attached to each crank are two single acting pumps of about fifteen inches diameter of plunger and two metres stroke. There are therefore twenty-four pumps, which, when the water wheels are averaging four revolutions per minute, should have a capacity of approximately eight million gallons per twenty-four hours.

In the reconstruction of the works, a large reservoir has been located on the high ground of the Marly plateau, and a cast-iron pipe along side of the arcade supplants its conduit and conveys the water to the reservoir, leaving the arcade only a huge monument of past usefulness and long service and of past methods of engineering practice.

The Marly reservoir is at an elevation of one hundred and fifty-six metres (512 feet) above the pumps. The lower portion of the force main is therefore subject to severe strain and some memoranda respecting it may be of interest.

I was unable to learn of the attendants at the pump-house how long this force main had been in service. A highway, on which the pump-house faces, skirts the bank of the river Seine. The force main passes under the highway, at right angles to it, and then commences the ascent of the high bluff toward the plateau and reservoir. The portion of the main that ascends the bluff lies at an angle of about 30° and is of flanged cast-iron pipes. Its appearance indicated that it is not of modern castings. It rests on concaved blocks of stones at intervals of about twelve feet and is entirely above and clear of the ground, which is graded to the same incline as the pipe. Some spare pieces of the force main lying at the head of the incline, had dimensions as follows : Length of each section, two metres (7.56 feet) ; internal diameter of pipe, 23.5 inches; thickness of pipe shell, 1.62 inches ; thickness of flanges, 1.87 inches; diameter of flange bolts, 1.25 inches.

At frequent intervals this inclined pipe is anchored, by iron straps, to masonry imbeded in the earth, and expansion joints are provided. The pipe alongside the arcade, on the plateau, which is subject to light pressure only, has socket and spigot joints.

The original Marly hydraulic works, including the dam, wheels and pumps, are said to have cost four million francs.

Since the accession of the Bonapartes to power the Versailles palace has not been used for a royal residence. The palace has become instead

a famous museum and gallery of paintings and sculptures; nevertheless, the fountains which the treasury of Louis XIV created are still the pride of the Parisian.

The garden, otherwise magnificent, contains eight principal fountains and additional large water basins, all adorned with figures in bronze and marble, and it is said to cost two thousand dollars to give a single exhibition of these *grandes Eaux*.

The playing of the fountains is usually heralded several days in advance, the regular dates being the first Sundays in the month from spring until autumn. Then great numbers of people from Paris and elsewhere assemble to view the fine spectacle, for the largest three jets rival the famous Chatsworth jet at the chateau of the Duke of Devonshire and the great jets of Trafalgar Square in London. Very naturally the popular interest in these remarkable works has centered in the Versailles garden exhibitions, but it is the hydraulic works at the opposite end that most evidence the genius of their projector, and there centers the greatest interest of those who can appreciate the skill, courage and confidence with which the difficult problem was grappled in such manner as to ensure the marked success that has followed through more than two centuries.

KANSAS CITY, Mo., April 8th, 1891.

J. M. Diven, Sec'y American Water Works Association:

DEAR SIR: I find myself unable to attend the convention but will send you a few notes on pumping engines, which as they are, views deduced from twenty years of experience with a large variety of engines, may be of sufficient interest to present to the association. It has become usual to designate pumping engines by their capacity for daily pumping, as one, three, five, or more millions, this has a local significance, but gives little idea of the plant to an outsider for the reason that the power of the engine must vary directly with the lift; it seems to the writer that the indicated horse power of the engines should also be given as a means of comparison as to cost, etc.

An engine of 100 indicates horse power, with 100 feet lift, is a five million gallon plant, with 200 feet lift, 2½ million gallon plant with 300 feet lift, 1⅔ millions, with 400 feet lift 1¼ millions, and with 500 feet lift but one million.

Let us suppose an ideal engine of 100 horse power, the lift is immaterial to our comparison; to be reasonable in our requirements we will give it a duty of 100 millions, its other qualities are ease of access to all its parts, and of attendance, and great reliability, requiring in a year's operation no necessary stoppage of over twelve hours. Say that this engine costs, set up, $25,000. Interest on plant, 10% coal $2.50 per ton of 2,000 lbs. Then the value of equally good engines of less duty would be:

For an engine giving a duty of					90	millions	.....	$21,500
"	"	"	"	"	80	"	.....	$17,000
"	"	"	"	"	70	"	.....	$12,500
"	"	"	"	"	60	"	.....	$8,000

At 40 millions the value becomes less than nothing. These figures will,

of course, change with change of data, but serve to indicate the hobby which is ridden by some builders and more users. It is made the first measure of value but is really second to durability and reliability.

Lost time with a pumping engine means more than the mere interest on the cost of the idle plant. Attendance goes on and the loss of the pump service is often far more important than both. It is probable that $15 per day would be a small average figure at which to place the loss due to the stoppage of a pumping engine of 100 horse power. Then if we compare our ideal engine with one of like economic value, but which in a year has been stopped ten days and had $500 spent on it in repairs, we find the second engine worth but $18,500; with 20 days stoppage and $1,000 in repairs, but $12,000; with 30 days stoppage and $1,500 in repairs, but $5,000, while $2,000 repairs with the same stoppage, sends it to the scrap pile.

These figures like the others will be largely modified by change of data, nor must we forget to make all proper allowance for plants working under exceptionally severe conditions. The ideal engine is not built yet, but we have some pretty good ones, enough so that many superintendents and engineers have begun to make comparisons. It will probably be a triple expansion engine, but not limited in speed by the pumps, at present large cylinders are required with motion far lower than they would be used for in other work. In large engines of this class, a sudden increase in water pressure may check motion so that the steam already tired from its effort in the small cylinder, may want to rest, and forget where it started for, a strong requirement for higher speed; but a serious objection to this lies in the effort required to raise the ordinary valve.

Few are aware that this is the cause of more accidents than anything else : A valve seated under water pressure covers a certain area of seat, and so closely does this pressure bring the surfaces in contact, together, that at the instant of change, the pressure below the valve must be sufficient on the smaller area, to overcome the resistance on the larger area of the top; it follows that for a mere instant, the pressure in the pump and consequent strain on all connected parts may be as much or even more than 50% in excess of the regular pressure.

This is so evanescent that it escapes notice, but none the less every part of the machine under this strain, receives a series of shocks as actual as the blows of a pile driver, and as continuous as the motion of the engine.

This shock increases with motion and pressure, and has resulted in the seeming necessity of slow moving pumps.

It can be readily seen however that if this shock could be eliminated or its effect relieved and the pumps so arranged as to cause no pulsation in the mains, the pumps could move at such a speed as would be proper for the engines if driving other machinery—and the plant of 5 millions become by this change, of double or triple the capacity, with the same weight and probably but slightly increased cost. These are not imaginary improvements but actual requirements which it is entirely practicable to meet, and which when met will not only add largely to the capacity of plant compared with weight and cost, but render it comparatively safer against accidents. Some engineers have weighed these points and partly provided for them, but the number of builders who have

adopted for rotative engines the valve action that serves well with duplex pumps, disregarding the shock caused by the engine passing its centres, have so far left the others in a pitiful minority. The competition now existing among builders and the knowledge of requirements among users will eliminate these crudities and eventually give us the ideal engine.

Respectfully submitted,

G. W. Pearsons.

Friday Evening, April 17, 1891.

Convention called to order by President Bull at 8 p. m., in Room 20 Continental Hotel.

The President: The Secretary has some applicants for membership.

The Secretary: I have the following applications for active membership:

Henry Hawkes, Water Purveyor, Brooklyn, N. Y.; W. W. Ruggles, Chief Engineer Water Department, Jersey City, N. J.; W. W. Mines, Superintendent Water Works, Camden, N. J.; William Gibson, Jr., Publisher Engineering Record, New York, N. Y.; Jacob Halbach, Secretary Water Board, Lancaster, Pa.; Jas. P. Herdic, Water Works Contractor, Williamsport, Pa.

On motion the rules were suspended and the Secretary directed to cast the vote of the Convention for the applicants.

Mr. Gardner: As our eleventh annual Convention draws to a close I wish to offer the following resolution:

Resolved, That the profound thanks of the American Water Works Association be and they are hereby tendered to Messrs. R. D. Wood & Co. for the invitation to hold this meeting in Philadelphia, and to the members of our local committee and the committee of reception for the lavish hospitality which in so princely a manner has been bestowed upon us.

And I move the adoption of the resolution.

Motion seconded and adopted by a rising vote.

Mr. Gardner: I have another well merited vote of thanks to offer:

Resolved, That the American Water Works Association thank the press of Philadelphia for a fuller and fairer account of its proceedings than has ever before been reported at previous meetings.

Resolution seconded and adopted with three cheers and a tiger.

MR. GARDNER: I have one more resolution, and one that it gives me great pleasure to offer:

Resolved, That the Association recognizes and appreciates the services of the President, Mr. W. B. Bull, and thanks him for his impartial rulings and able supervision of the affairs of the Association during the past year.

And I move the adoption of the resolution.

Motion seconded and carried by a standing vote with three cheers and a large sized tiger.

MR. DECKER: We owe much to the ladies who attend the Conventions. They are a large factor in making the meetings a success. Some recognition should be made. They should know that we appreciate their attendance and the influence which it wields.

MR. GARDNER: I move that Mr. Decker, as Secretary, be instructed to thank each attending lady individually for her attendance and to extend an invitation and request to her to attend the next Convention and to use her influence to induce other ladies to attend.

Motion seconded by Secretary and carried.

THE PRESIDENT: The ladies want some expression of their appreciation of the many courtesies they have received, both from the local committee and their ladies, and from Mr. Wannamaker and the Managers of Horticultural Hall.

MR. GARDNER: I move that a special resolution be adopted thanking the local committee and ladies and Mr. Wannamaker and the Managers of Horticultural Hall for the courtesies extended to our ladies, and that Mr. Ryle be appointed a committee of one to draft such resolution.

Resolution offered by Mr. Ryle:

Resolved, That the sincere thanks of the ladies accompanying the members of the American Water Works Association are hereby tendered to the local committee for the many courtesies extended to them by them and their ladies during this eleventh annual Convention; and

Resolved, That the ladies attending this Convention wish to and hereby do express their appreciation of the courtesies shown them by Mr. Wannamaker; and they hereby extend their thanks to the Managers of Horticultural Hall for the elegant flowers received by them on their visit to the Hall.

Motions seconded and adopted.

THE PRESIDENT: We can congratulate ourselves on the success of this Convention, both as to the work accomplished and the many pleasures enjoyed. There have been no drawbacks, even the weather has favored us. We have never enjoyed a more successful meeting.

MR. GARDNER: I now move that we adjourn to meet next year on "Kelley's Island" at a date to be fixed by the Executive Committee.

Motion seconded by Mr. Decker and carried.

J. M. DIVEN, Secretary.

THE EXHIBITS.

Though the accomodation for exhibitors was not all that could be desired there was, nevertheless, a large number of very creditble exhibits. Two rooms were provided, one in the basement for the heavier articles and a smaller room on the office floor for light articles, drawings &c. A very general desire was expressed that this feature of our conventions receive more attention and that a special committee should be appointed to take charge of this department at future conventions.

The following named manufacturers were represented as follows:

Walworth M'f'g Co ..... B. F. Polsey
Fisher Governor Co ..... E. W. Harris
Newark Tapping Machine ..... Wm. Clark
Rensselaer M'f'g. Co ..... Ostavius Jones
Dean Steam Pump Co ..... Wm. P. Dallett
Standard Thermometer Co ..... H. P. Hutchinson
The Brass and Iron Works ..... G. W. Greenwood
E. H. Kellogg & Co ..... C. H. Hammond
Holyoke Hydrant Co ..... H. C. Folger, E. L. Abbott
Reihle Testing Machine Co ..... Reihle Bros
Illinois Malleable Iron Co ..... Alex H. Austin
Eddy Valve Co ..... Jno. Knickerbocker
Thompson M'f'g. Co .....
Fairbanks & Co ..... A. G. Paul
R. D. Wood & Co ..... J. Wister, Jesse Garrett, Allan T. Prentice
Galvin Brass & Iron Works ..... Mr. O'Brien, Mr. Lynch
National Tube Works Co ..... A. J. Guilford, H. E. Keeler
Union Water Meter Co ..... G. H. Carr, Phineas Ball
Ludlow Valve Co ..... J. T. Christie
H. R. Worthington ..... C. A. Hague, Geo. B. Ferguson
Chattanooga Pipe Co ..... Mr. Lewdling
Jackson & Woodin M'f'g Co ..... Fred H. Eaton
Isaac S. Cassin & Co ..... Isaac Cassin, Jr
Clark Tapping Machine Co ..... Chas. Fourse
Chas. Miller & Sons ..... J. S. Murray
Hays M'f'g. Co ..... J. M. Hays
Norfolk City Water Works ..... H. P. Smith
A. P. Smith Tapping Machine ..... Anthony P. Smith

The Press.

The technical and local press was represented af follows:

TECHNICAL PRESS.

Engineering Record ..... Robt. J. Parvin, Phila. Agent. Frank W. Skinner, Editor. William Gibson, Publisher.
Western Fireman ..... B. L. Tomes
Fire & Water ..... Jos. G. Gilbert. F. W. Sheppard.
Engineering News ..... M. N. Baker

PHILADELPHIA PRESS.

The Press.....W. K. Buckingham
Public Ledger.....F. W. Harold
The Call.....C. J. Phillips
The Item.....Daniel Patton
Evening Telegraph.....L. W. Wallazz
Evening Bulletin.....A. E. Blood

The Social Feature.

In Philadelphia, as elsewhere, we met with the most lavish hospitality. The program laid out by the Local Committee and Reception Committee was a most attractive one and was carried out in a manner that showed thorough organization and untiring exertion on the part of the various Committees. In addition to the entertainment provided for by the Local Committee we received numerous invitations which we were unable to accept.

The rooms of the Engineers Club of Philadelphia were placed at the disposal of members during their stay.

The Reception.

Tuesday evening a reception was given to the members of the Association and Ladies, at The Manufacturer's Club, the ball room and dining rooms of which were elegantly decorated and placed at the disposal of the Reception Committee by the Club. We were received by Mayor Stewart and other city officials. The members of the Reception Committee and their ladies did everything to make the reception the elegant affair which it most certainly was. During the evening music was rendered by a string band hidden behind banks of flowers and plants in an alcove.

The Drive.

At 2 P. M. Thursday we left the hotel in a number of handsome coaches each drawn by four horses and each containing at least one Philadelphian to point out the buildings and objects of interest. The route was up market Street to Broad, to Diamond, to the Park and around the Spring Garden Reservoir to the Spring Garden Pumping Station.

The beautiful grounds at the Pumping Station were in perfect order, the display of hyacinths and tulips in the numerous flower beds were truly beautiful, one bed high up on the rocks attracting particular attention.

As we passed into the Engine Room each member and visitor was presented with a handsome Souvenir in the form of a beautifully bound

book of photographs of the Pumping Stations, reservoirs, public building, other notable buildings and views from the City Hall tower.

After an inspection of the perfectly kept engines, boilers and other features of the Station we took the Coaches and were driven to the Fairmont Water Works. Here in addition to the pumping plant, we were shown some of the relics of the old water works spoken of in Mr. Geyelin's paper. Among them some pieces of wood pipe and the first iron valve used on the system.

From Fairmount we were driven over the Girard Ave., bridge to the West Park and up the Lansdowne drive to Horticultural Hall. Here each lady was presented with a beautiful boquet of roses and lily of the valley.

We next visited the Belmont Water Works. In one of the flower beds, which adorn the grounds at the station, was the word "*Welcome*" in smilax and roses.

From Belmont we were driven to the Belmont Mansion. Here an excellent photograph of the party was taken; after which lunch was served.

After lunch Mr. John Birkenbine, Chairman of the reception committee, in a brief speech introduced President Bull. Mr. Bull, in a few words, expressed the appreciation of the members for the unbounded hospitality shown to them.

Entering the coaches again, we returned to the hotel, which we reached just in time to escape a shower.

The Trip to Camden and Atlantic City.

At 9 o'clock Friday morning, under the care of the local committee, we took the Market St., Ferry to Camden, where we boarded a special train on the Pennsylvania Railroad, which took us to the Camden Iron Works, where President Walter Wood, Emile Geyelin, L. R. Lemoin, Superintendent Lewis S. Wright and other members and employees of the Company met us and escorted us through the works; a map of which each member had been provided with, as a souvenir and guide. We were treated to a rather unexpected exhibition of the thoroughness with which water pipes were tested at this establishment. But as Brother Holden kindly took care of most of the water which escaped from a twelve inch pipe that burst under a three hundred pound hammer test, little harm was done; as Mr. Holden is used to water and assured us that none got inside.

The Special was in waiting when we came out at the opposite end of the works and we were whirled away Oceanwards, and soon began to sniff the invigorating ocean air. On our arrival at Atlantic City we went to the United States Hotel in the vast dining hall of which hotel we were soon enjoying a sumptuous banquet.

It was whispered that some of the members had elaborate after-dinner speeches and complimentary resolutions prepared for this occasion, and that much bottled up eloquence was lost on account of the great hurry on the part of the members from the interior, to get out for a nearer inspection of the ocean.

Some went for a drive, others for a promenade on the famous "board walk" and others for a stroll on the beach, and all enjoyed a most delightful afternoon.

It was a perfect day and it was with reluctance that we repaired to the station at the appointed time to take the train for the return to Philadelphia.

In addition to the members of the Local Committee, we are indebted to the following named gentlemen, members of the

Local Committee for the Reception of the American Water Works Association.

Geo. A. Allison, Treas. & Supt., Water Works, Burlington, N. J.
James C. Brooks, Southwark Foundry, 5th & Washington, Philadelphia.
John Birkbine, 25 N. Juniper, Philadelphia.
Jas. A. Bartlett, H. R. Worthington, 145 Broadway, N.Y.
D. Brown Chew, Gloucester Foundry, Gloucester, N. J.
John E. Codman, Philadelphia Water Department.
Wm. Cramp & Son, Beach and Norris, Philadelphia.
Frank W. Dilks, Representative Blake Pump, Arch north 5th., Phila.
John Donaldson, 1939 Arch Street.
Wm. P. Dallett, Deane Steam Pump Co., 49 N. 9th St., Philadelphia.
Wm. M. Deutch, National Filter Co,, 145 Broadway, N. Y.
A. J. Fuller, Water Department, Philadelphia.
Wm. Good, Southwark Foundry, 5th & Washington Sts.
F. L. Haud, Sup't Philadelphia Water Works, Juniper & Filbert Sts.
Frank Hersey, Hersey Meter Co., S. Boston, Mass.
Mr. Hyatt, Hyatt Pure Water Co., 16 to 20 Cortlandt St., N. Y.
Wm. B. Harper, Sup't., Water Works, Reading, Pa.
Washington Jones, P't Richmond Iron Works, Philadelphia.
A. K. Joyce, Sup't., Water Works, Bristol, Pa.
John C. Kelley, Notional Meter Co., 252 Broadway, N. Y.
L. R. Lemoine, of R. D. Wood & Co., 400 Chestnut St., Philadelphia.
James P. Michellon, Bullitt Building, Philadelphia.
J. T. Morris, Pt. Richmond, Philadelphia.
Henry G. Morris, Drexel Building, Philadelphia.
Howard Murphy, Sec'y., Engineer's Club, Girard St., Philadelphia.
Wm. Mines, Sup't Water Works, Camden, N. J.
Morrison, Allen & Co., 145 Broadway, N.Y.
A. H. McNeal, Burlington, N. J.
W. E. Newhall, of R. D. Wood & Co.
Oliphant Filter Co,, 400 Chestnut Street, Philadelphia.
Robert J. Parvin, 1050 Drexel Building, Philadelphia.
F. A. Riehle, 413 Market St., Philadelphia.
Wm. Sellers, 1600 Hamilton St., Philadelphia.
M. Spangler, Pres't., Engineers' Club, Girard St., Philadelphia.
E. F. Smith, Engineer, Schuylkill Canal, Office Reading R. R. Co.
Wm. P. Tatham, Fifth below Walnut, Philadelphia.
W. W. Whitby, Water Department, Philadelphia.
Walter Wood, of R. D. Wood & Co., 400 Chestnut St., Philadelphia.
Andrew Wheeler, Pres't Morris Tasker Co., 400 Chestnut St., Phila.
Dr. Wahl, Franklin Institute, Seventh N. Market St., Philadelphia.

P. D. Wanner, of Mellert Iron Foundry, Reading, Pa.
J. D. Williamson, of Williamson Bros., 2735 E. York St., Philadelphia.

The following named ladies were in attendance :

Mrs. Wm. Ryle.....Paterson, N. J
" H. E. Keeler.....Chicago, Ill
Miss Georgie Keeler..... " "
Mrs. A. J. Guilford..... " "
" Thompson.....Davenport, Ia
" A. N. Denman.....DesMoines, Iowa
" C. S. Brown.....Toledo, Ohio
" A. G. Paul.....New York, N. Y
" Jos. P. Rider.....S. Norwalk, Conn
" J. A. Tilden.....Boston, Mass
" Sam'l McElroy.....Brooklyn, N. Y
" H. G. Holden.....Nashua, N. H
" Solmon.....Lowell, Mass
" A. S. Glover.....Boston, Mass
" M. A. Brown.....Perth Amboy, N. J
" J. A. Bond.....Wilmington, Del
Miss Minnie Woodruff.....Bridgeton, N. S

The Ladies' Visit to Wanamaker

Mr. Ogden, Mrs. Codman and others, conducted the ladies to the store of John Wanamaker, where they were received by Mr. Wanamaker's representative and given the freedom of the store. The party was taken through the different departments by two experienced lady guides, who pointed out the most interesting objects, from millinery, jewelry, bric-a-brac, &c., to the most useful of household utensils. After having a general idea of the store, the party was invited to an elegant lunch served in a private room, where flowers, and fine table decorations were added to the attractive lunch.

In Memoriam.

Dr. George Baird,

Died March 7, 1891.

A tragedy which had been long predicted occurred on Eleventh street at twenty minutes to 11 o'clock this morning when Dr. Geo. Baird, one of the oldest physicians of Wheeling, a member of the city water board, ex-member of council and of the board of public works, a member of the board of directors of the Wheeling bridge and terminal railway company and a man very prominent in local politics and municipal government matters, was shot twice and almost instantly killed by Dr. George O. Garrison, member of the state board of health, late health officer of the city and a man widely known over a large section of country as an authority on matters of sanitation.

Dr. Baird became a member of the American Water Works Association at the Chicago Convention in 1890. Though a new member he already gave great promise of becoming a valuable one as Water Supply was a question in which he took very great interest, and he was on the list of members promising to contribute to the Philadelphia Convention, Some Sanitary Phase of the Question being the subject he intended writing upon. In his death this Association has met with a great loss—the loss of an earnest worker

A local paper gives his life history as follows: "There were probably few better known citizens in the community than Dr. George Baird, the victim in the awful tragedy. He has been a man who has wielded considerable influence in this section, and has been a moving factor in many of the public enterprises of the city. He was born in Washington, Pa., November 30, 1826, his father being a merchant there, and was graduated at Washington and Jefferson College in 1847, and was a schoolmate with Secretary Blaine, whom he entertained on one of his visits here. Among others who graduated in the same class was Dr. R. W. Hazlett, James C. Hervey, and Mr. Holliday, a former attorney at Moundsville. He afterward took a regular medical course at the University of Pennsylvania at Philadelphia, graduating in 1852.

He came to Wheeling in 1852 and married a sister of Mr. Sam McCullough. He has been a prominent man in local affairs and was Mayor of the city for two years during the war, served on the Board of Education, was at one time President of the Second Branch of Council, at another time member of the First Branch, was a member of the Board of Public Works and of the Water Water Board and Gas Trustees. In medical circles he was also quite prominent, being a member of the American Medical Society of which he was President in 1885, and a director for the Asylum for the deaf, dumb and blind. He was also one of the warm advocates of the Wheeling Bridge and Terminal Company, and at the time of his death was one of the directors of the company. He was identified with several secret societies, and was especially prominent in the Odd Fellows and Masonic lodges. He leaves a wife and six children, Dr. Reed Baird, George Baird, Jr, Secretary of the Water Board, Will Baird, who is studying medicine at Philadelphia, Misses Sarah Baird, Jennie and Todd Baird.

Dr. Baird has ever been a public spirited citizen, and no one was more progressive in matters in all that tended to build up and promote the interests of the city. At the time of his death he was especially interested in securing for the city a better water supply."

FINANCIAL STATEMENT.

RECEIPTS.

1890.			
May 20.	Balance cash on hand	$	129 91
"	E. L. Abbott, fee and dues to 1891		8 00
"	J. Nelson Tubbs, dues to 1890		6 00
"	W. W. Barnard, fee and dues to 1891		8 00
"	Andrew W. Stevens, " "		8 00
"	A. J. Guilford, dues to 1891		3 00
"	Robert N. Ellis, fee and dues to 1891		8 00
"	J. B. Fish, fee		5 00
"	Rensselaer Mfg. Co., fee and dues to 1891		13 00
"	O. H. Jewell & Sons, " "		13 00
"	John Knickerbocker, " "		8 00
"	Edw. Armstrong, " "		8 00
"	H. E. Keeler, dues to 1890		3 00
"	J. B. Page, fee and dues to 1891		8 00
"	Fisher Governor Co., dues to 1890		3 00
"	Geo. Hornung, " 1891		3 00
"	J. T. Lakin, " 1890		3 00
"	R. D. Wirt, " "		6 00
"	S. B. Russell, " 1891		3 00
"	A. G. Moore, " 1890		3 00
"	Wm. Ryle, " 1892		6 00
"	H. F. Dunham, " 1890		3 00
"	Rouse & Hill's Mfg. Co., dues to 1891		3 00
"	D. M. Clark, " "		3 00
"	W. H. Laing, " "		3 00
"	C. N. Priddy, " "		3 00
"	Chas Hood, " "		3 00
"	G. H. Benzenberg, " "		6 00
"	F. W. Gerecki, " "		3 00
"	A. N. Denman, " 1890		3 00
"	C. M. Foote, " 1891		3 00
"	H. G. Holden, " 1890		3 00
"	W. G. Richards, " 1891		3 00
"	B. F. Jones, " 1890		3 00
"	C. A. Jones, fee and dues to 1891		8 00
"	Geo. B. Wing, " "		8 00
"	E. S. Wills, dues to 1890		9 00
"	J. T. Sawyer, " "		3 00
"	J. A. Bond, " 1891		3 00
"	Thos. J. Neville, dues to 1890		3 00
"	Hyatt Pure Water Co., dues to 1891		3 00
"	F. E. Sickles, fee and dues to 1891		8 00
"	I. L. Lyman, dues to 1891		9 00
"	Hersey Meter Co., dues to 1891		3 00
"	J. H. Watts, " "		6 00
"	J. H. Wilkerson, " "		3 00
"	Robert Hawkins, fee and dues to 1891		8 00

May 20.	Fred. Wing, dues to 1890	3 60
"	Z. S. Spaulding, fee and dues to 1891	8 00
"	T. H. Tracey, " "	8 00
"	Lafe W. Straw, " "	8 00
"	R. R. Parkins, " "	8 00
"	A. G. Paul, " "	13 00
"	Western Valve Co., " "	13 00
"	J. F. Sullivan, " "	8 00
"	Allen T. Prentice, " "	8 00
"	Jos. E. Haynes, " "	8 00
"	Tuerk Hydraulic Power Co., fee and dues to 1891	13 00
"	I. P. Rumsey, " "	8 00
"	American Filter Co., " "	13 00
"	James Owen, " "	8 00
"	W. H. Marsh, dues to 1890	3 00
"	J. D. Griffin, fee and dues to 1891	8 00
"	F. W. Jackson, dues to 1891	3 00
"	Galvin Brass and Iron Co., dues to 1890	3 00
"	J. B. Rider, fee and dues to 1891	8 00
"	W. B. Rider, " "	8 00
"	Ira S. Schrop, " "	8 00
"	Thos. W. Yardley, " "	8 00
"	Millard F. Wright, " "	8 00
"	D. A. B. Bailey, " "	8 00
"	Jno. C. Kelley, " "	8 00
"	W. A. Alexander, " "	8 00
"	H. S. Raymond, " "	8 00
"	Stephen A. Cahill, " "	8 00
"	S. Q. Seiver, " "	8 00
"	Dr. G. Baird, " "	8 00
"	N. A. Partridge, " "	8 00
"	J. F. Austerlund, " "	8 00
"	W. C. Mitchell, " "	8 00
"	Erastus G. Smith, " "	8 00
"	W. H. Glore, " "	8 00
"	Geo. H. Pierson, " "	8 00
"	W. R. Northway, " "	8 00
"	C. M. Nichols, " "	8 00
"	H. C. Parrott, dues to 1891	6 00
"	F. W. Holly, " "	3 00
"	P. H. Linneen, " "	3 00
"	F. A. W. Davis, " 1890	3 00
"	C. A. Judson, " 1891	6 00
"	J. R. Maxwell, fee and dues to 1891	8 00
"	T. N. Hooper, dues to 1890	6 00
"	G. W. Dudley, fee	5 00
"	J. I. Jones, dues to 1891	12 00
"	P. M. Hanley, dues to 1891	6 00
"	C. S. Brown, dues to 1890	3 00
"	E. W. Frost, " "	9 00
"	J. A. Cloud, " "	3 00
"	W. H. Fritchman, dues to 1891	6 00

May 20,	B. F. Stevens,	"	"	3 00
"	F. T. Moody,	"	"	12 00
June 7,	E. A. Brower,	"	"	3 00
May 22,	J. F. Gleason,	fee and dues to	1891	8 00
"	M. W. Corbet	"	"	8 00
"	Anthony P. Smith,	"	1893	13 00
July 24,	Edw. P. Allis & Co.,	"	1891	13 00
" 30,	Sam'l G. Artingstall,	"	"	8 00
" 31,	John C. Chase,	dues to	1890	3 00
"	Harry G. Koch,	"	1891	3 00
Aug. 25,	John R. Todd,	"	1890	3 00
"	Norfolk City Water Co.,	dues to	1890	3 00
Aug. 28,	W. H. Messenger,	"	1891	3 00
"	John H. Turner,	fee and dues to	1891	8 00
"	R. B. C. Bement,	dues to	1891	3 00
Sept. 13,	Sylvanus Ayres, Jr.,	dues to	1891	3 00
" 30,	H. Mueller,	"	1890	2 00
"	E. L. Dunbar,	"	1891	6 00
Oct. 4,	H. C. Heermans,	"	"	6 00
Oct. 6,	W. C. McConnell,	"	"	6 00
"	Alex. G. Cattell,	"	"	6 00
"	H. C. Hodgkins,	"	"	6 00
"	Whitney Conant,	"	"	6 00
"	Canton Water Works,	fee and dues to	1891	13 00
Oct. 7,	Jarvis B. Edson,	dues to	1891	6 00
"	J. L. Mott Iron Works,	dues to	1891	6 00
"	National Meter Co.,	"	"	6 00
"	Hardwicke & Ware,	"	"	6 00
"	Edwin Darling,	"	1890	3 00
"	Eddy Valve Co.,	"	1891	6 00
"	R. D. Wood & Co.,	"	"	6 00
"	L. Halsey Williams,	"	"	6 00
Oct. 8,	Addyston Pipe and Steel Co.,	dues to	1891	6 00
"	A. F. Kent,	dues to	1890	3 00
"	Bingham & Taylor,	dues to	1891	6 00
"	A. W. Morgan Mfg. Co.,	dues to	1891	6 00
"	J. M. Randall,	"	"	6 09
"	E. H. Kellogg & Co.,	"	"	9 00
"	W. B. Bull,	"	1890	3 00
"	The Michigan Pipe Co.,	"	1891	6 00
Oct. 9,	M. T. Stookey,	"	"	6 00
"	Gordon Steam Pump Co.,	"	1890	3 00
"	Chattanooga Pipe and Foundry Co.,	dues to	1891	6 00
"	L. H. Gardner,	"	1890	3 00
"	Charles A. Hague,	"	1891	6 00
"	A. R. Leeds,	"	1890	3 00
"	H. Mueller,	"	"	1 00
Oct. 10,	Ohio Pipe Co.,	"	1891	6 00
"	J. T. Fanning,	"	1890	3 00
"	National Tube Works,	"	1891	6 00
Oct. 11,	Dennis Long & Co.,	"	1890	3 00
"	N. Wingfield,	"	1891	6 00

Oct. 11,	T. S. Moorhead,	"	"	9 00
Oct. 13,	Charles B. Brush,	"	1890	3 00
"	S. E. Babcock,	"	1891	6 00
"	R. A. Robertson, Jr.,	"	"	6 00
"	C. W. Morse,	"	"	6 00
"	Spiral Weld Tube Co., fee and dues to 1891			13 00
"	Union Water Meter Co., dues to 1891			6 00
"	Phinehas Ball,	"	"	6 00
"	F. Wm. Raeder,	"	"	6 00
"	W. S. Kuhn,	"	"	6 00
"	Geo. F. Blake Mfg. Co.,	"	"	6 00
"	Samuel McElroy,	"	1890	3 00
"	Fred. Adee & Co.,	"	1891	6 00
Oct. 14,	Ripley & Bronson,	"	"	6 00
"	Isaac S. Cassin,	"	"	6 00
Oct. 15,	J. J. R. Croes,	"	"	6 00
Oct. 16,	F. L. Fuller,	"	"	6 00
"	Chapman Valve Mfg. Co.,	"	1890	3 00
"	Hays Mfg. Co.,	"	1891	6 00
Oct. 18,	Rudolph Herring,	"	"	6 00
"	Shickle, Harrison & Howard Iron Co., dues to 1891			6 00
"	Wm. B. Sherman,	"	"	6 00
"	H. De. C. Richards,	"	"	6 00
Oct. 20,	Chas. Elliott,	"	"	6 00
"	Robt. K. Martin,	"	1890	3 00
"	Reliance Oil and Grease Co.,	"	"	3 00
"	Desmond Fitzgerald,	"	1891	6 00
"	Willis Chipman,	"	"	6 00
"	J. W. Henion,	"	1890	3 00
Oct. 21,	L. J. LeConte,	"	"	3 00
Oct. 22,	J. H. Decker,	"	"	3 00
Oct. 27,	Jones & Laughlin,	"	1891	6 00
"	Buffalo Steam Pump Co.,	"	"	6 00
"	J. P. Donahue,	"	1890	3 00
"	E. H. Brown,	"	1891	6 00
"	Geo. H. Robertson,	"	1890	3 00
"	Jas. A. McWilliams,	"	"	3 00
Nov. 3,	S. W. Harris,	"	1891	6 00
"	J. B. Clow & Sons,	"	1890	3 00
"	Jno. W. Hill,	"	1891	6 00
"	J. D. Cook,	"	1890	3 00
Nov. 4,	B. M. Espey,	"	1891	6 00
Nov. 7,	E. H. Phipps,	"	"	6 00
Nov. 11,	Samuel A. Strang,	"	"	9 00
Nov. 12,	G. W. Brackenridge,	"	"	6 00
Nov. 17,	A. B. Gaines,	"	"	6 00
Nov. 18,	A. L. Brown,	"	"	3 00
Nov. 20,	Chas. F. Wood, fee and dues to 1891			8 00
"	Wilson Henderson, dues to 1891			3 00
Dec. 8,	R. Gervase Elwes,	"	1890	3 00
Dec. 10,	A. H. McNeil,	"	1891	9 00
"	M. L. Holman,	"	1890	3 00

Dec. 20,	L. C. Burns,	" "	3 00
"	C. F. Manning,	" 1892	6 00
1891.			
Jan. 1,	Wm. Ludlow,	" 1891	6 00
Jan. 26,	A. H. Martine,	" "	6 00
Jan. 29,	Jno. Smith, fee and dues to 1892		8 00
Feb. 5,	Moses Joy, Jr.,	" 1891	6 00
Feb. 7,	H. H. Harrison,	" 1890	6 00
Feb. 20,	Standard Thermometer Co., fee and dues to 1892		13 00
Feb. 26,	Murray Forbes,	" " "	8 00
Mch. 9,	Wm. Molis, dues to 1891		3 00
"	Revolving Purifier Co., fee and dues to 1892		13 00
Mch. 13,	F. H. Pond, dues to 1890		3 00
Mch. 19,	Chas. Miller & Son, fee		10 00
Mch. 27,	Jacob L. Kuehn, fee and dues to 1892		8 00
"	D. C. Fry, dues to 1891		3 00
Mch. 28,	Chas. Fred. Allen, fee		5 00
Mch. 30,	E. Mather, fee and dues to 1892		8 00
Apr. 1,	Peter E. Farnum, fee and dues to 1891		8 00
Apr. 3,	Jno. Caulfield, dues to 1891		6 00
"	Gilbert Murdock, dues to 1892		9 00
Apr. 4,	Hugh F. Doran, fee and dues to 1892		8 00
Apr. 6,	Chas. P. Allen, dues to 1891		9 00
Apr. 7,	Josiah Thompson, fee and dues to 1892		8 00
"	Isaac S. Cassin, Jr.,	" "	8 00
Apr. 9,	Peter Milne, Jr., dues to 1890		12 00
"	Geo. E. Booker, fee and dues to 1892		8 00
Apr. 11,	Jos. H. White,	" "	8 00
"	W. E. Shannahan,	" "	8 00
"	L. J. Wagner,	" "	8 09
"	J. M. Diven, dues to 1891		3 00
"	H. P. Martin,	" "	3 00
			$1,564 16

DISBURSEMENTS.

1890.			
May 19,	Paid Express charges on trunk to Chicago	$	2 70
"	" for trunk strap		50
"	" Express charges on trunk from Chicago to Elmira		4 30
May 20,	" Lomas & Holway, for report'g Chicago Convention		100 00
June 25,	" for postage stamps		5 00
"	" Express on stationery from New York		60
"	" Elmira Advertiser Ass'n for printing		59 04
July 17,	" for postage stamps		5 00
July 18,	" freight on books, etc., from J. H. Decker		17 10
July 30,	" Slote & James for Membership Ledger		5 75
Aug. 9,	" postage on Proceedings		30 00
Aug. 25,	" " "		5 00
Sept. 3,	" J. Y. Johnston for stationery		24 30
Sept. 8,	" Express on letter-heads, etc., to Prest. Bull		1 00
"	" " Proceedings to P. H. Linneen		60
"	" " " J. H. Decker		1 35

Oct. 1,	"	for postage stamps	2 00
Oct. 4,	"	" "	1 00
Oct. 14,	"	" "	2 50
Oct. 20,	"	for receipt books for badges, etc	60
Nov. 3,	"	for postage stamps	2 00
Nov. 20,	"	Express on Proceedings to Monjeau, Decker and Wood	2 65
Nov. 26,	"	Elmira Advertiser Ass'n for printing Proceedings	396 13
Nov. 28,	"	for postage stamps	3 00
Nov. 29,	"	Express on Proceedings to J. P. Donahue	16
Dec. 8,	"	for postage stamps	5 00
Dec. 16,	"	Elmira Advertiser Ass'n for envelopes	1 50
1891.			
Jan. 15,	"	for envelopes for mailing badges	5 50
Jan. 21,	"	for postage stamps	12 00
Mch. 4,	"	Postal Telegraph Co	1 14
Mch. 13,	"	J. Y. Johnston for letter-heads	2 75
Mch. 20,	"	for postage stamps for mailing programmes	20 00
Mch. 27,	"	for postage stamps	5 00
Mch. 28,	"	" "	1 00
Apr. 3,	"	Postal Telegraph Co	1 22
Apr. 4,	"	for ribbon for badges	3 90
Apr. 8,	"	for paper wrappers	55
Apr. 8,	"	for seals	20
Apr. 11,	"	Elmira Advertiser Ass'n, printing circulars and programmes	37 75
Apr. 17,	"	J. M. Diven, Secretary, salary	400 00
		Balance cash on hand	406 15
			$1,564 16

LIST OF MEMBERS.

AMERICAN WATER WORKS ASSOCIATION.

1891.

HONORARY.

Y. Nakajima, Imperial University.....Tokio, Japan

ACTIVE.

Abbott, E. L., Hydraulic Eng. .....12 Temple Court, N. Y
Alexander, W. A., Sup't Penna. Water Co.....Wilkinsburg, Pa
Allen, Chas. Fred., Treas. Water Co. .....Hyde Park, Mass
Allen, Chas. P., Chief Eng. Citizen's Water Co.....Denver, Col
Alsterlund, J. F., Ch'f Eng. Water Works.....Moline, Ill
Andrews, Jas. H., Sup't Water Works.....Central Falls, R. I
Andrews, M. L., Sup't Water Co. .....Arkansas City, Kans
Archer, James, Water Co.....Denver, Col
Armstrong, Edw., Sup't Water Works .....Alegheny City, Pa
Artingstall, Samuel G., Civil Eng.....Chicago, Ill
Ayres, H. W., C. E. Water Wo.ks.....Hartford, Conn
Ayres, Sylvanus, jr., Mgr. Water Works.....Bound Brook, N. J
Babcock, S. E., C. E. Water Works.....Little Fall, N. Y
Bailey, D. A. B., Sup't Water Works.....Findlay, O
Ball, Phinehas, Hydraulic Eng.....Worcester, Mass
Bardard, W. W., Executive Committee.....Rochester, N. Y
Barnet, Jno., Sup't Water Works.....LaFayette, Ind
Barney, W. H., Sup't Water Works.....Milford, Mass
Barrows, F. C., Chairman Water Com.....Minneapolis, Minn
Beach, G. E., Hydraulic Eng.....Minneapolis, Minn
Bement, R. C. B., Ch'f Eng. Duluth Water Co.....St. Paul, Minn
Benzenberg, G. H., Ch'f Eng. Water Dep't.....Milwaukee, Wis
Bergstrom, Andrew, Mechanical Eng. Water Works..Minneapolis, Minn
Birkinbine, Harry.....Philadelphia, Pa
Bishop, E. H., Sup't Water Works.....Wahpeton, Dak
Bixby, Walter. A., Sup't Water Works.....Galena, Ill
Bolling, Chas. E., Sup't Water Works.....Richmond, Va
Bond, Joseph A., Ch'f Eng. Water Dep't.....Wilmington, Del
Booker, Geo. E., Ch'f C. S. V. W. W. Co. .....San Francisco, Cal
Bowen, Wm., Mechanical Eng.....Davenport, Ia
Brackenridge, G. W. Pres't Water Co.....San Antonio, Tex
Brooks, Isaac W., Pres't Water Co.....Torrington, Conn
Brower, Edw. A., M. E. Water Works.....Lyons, N. Y
Brown, A. L., M. E. Water Works.....Salem, Oregon
Brown, Calvin S., with Hersey Meter Co. .....Boston, Mass
Brown, E. H.....Grass Valley, Cal
Brown, J. Henry, Sup't Mystic Div. Water Dep't.....Boston, Mass
Brown, Milton A., Sup't Water Co.....Perth Amboy, N. J
Brush, Chas. B., C. E. & Sup't Water Works.....Hoboken, N. J
Buehner, Phillip, Water Works Contretor.....Portland, Oregon

Bull, William B., Sup't Water Works..... Quincy, Ill
Burns, L. C., Sec'y Water Co..... St, Joseph, Mo
Burnett, Musco, Sup't Water Works..... Paducah, Ky
Cahill, Stephen A., Sup't Water Works..... Manistee, Mich
Callahan, A. F., Director Water Co..... Louisville, Ky
Cameron, W. L., Sup't Water Works, with J. B. Clow & Sons, Chicago, Ill.....
Campbell, D. F., Sup't Water Co..... Travers City, Mich
Carlin, Phil., Sup't Water Works..... Souix City, Ia
Carson, J. M., C. E. & Sup't Water Works..... Danville, Ill
Case, L. N., Sec'y Water Works..... Detroit, Mich
Cassin, Isaac S., Hydraulic Eng., 1404 N. 12th St..... Phaladelphia, Pa
Cassin, Isaac, jr., Hydraulic Eng., 2,906 Girard ave..... Philadelphia. Pa
Cattell, Alex. G., Pres't. Merchantville Water Co..... Camden, N. J
Caulfied, Iohn, Sec'y Water Board..... St. Paul, Minn
Chambers, J. W., M. E. Water Works..... Birmingham, Ala
Chandler, Geo. H., Eng. Water Works..... Kalamazoo, Mich
Chase, John C., C. E. & Sup't Water Works..... Wilmington, N. C
Chipman, Willis, Ch'f Eng. Water Co..... Brockville, Ont
Clark, D. M., Sec'y & Treas. Water Co..... Elyria, Ohio
Clark, Ezra, Pres't & Su'pt Water Commission..... Hartford, Conn
Clayton, R. M., City Engineer,..... Atlanta, Ga
Cloud, J. A., Constructing Eng..... Jacksonville, Fla
Coggeshall, R. C. P., Sup't Water Works..... New Bedford, Mass
Cole, John A., Civil Eng..... Hyde Park, Ill
Conant, Whitney, Sec'y Water Co..... Long Branch, N. J
Cook, Edward C., Constructing Eng..... Tiffin, Ohio
Cook, J. D., Consulting Eng..... Toledo, Ohio
Corbet, M. W., Sup't Water Works..... Aurora, Ill
Croes, J. J. R., Consulting Eng., 13 Willard St..... New York, N.Y
Dalzell, R H., M. E., 512 Phœnix bldg..... Chicago, Ill
Darling, Edwin, Sup't Water Works..... Pawtucket, R. I
Davis, Chester B., Hydraulic Eng..... Chicago, Ill
Davis, F. A. W., Pres't & Treas. Water Co..... Indianapolis, Ind
Day, L. D., Civil Eng..... Minneapolis, Minn
Decker, J., H., with H. R. Worthington, 86 Liberty St., New York, N. Y
Denman, A. N., Sec'y Water Co..... DesMoines, Ia
Diven, J. M., Sup't Water Works Co..... Elmira, N. Y
Donahue, J. P., Vice-Pres't & Sup't Water Co..... Davenport, Ia
Doran, Hugh F., Sup't Water Works..... Port Huron, Mich
Doyle, F. P., Sec'y & Sup't Water Co..... Petaluma, Cal
Dudly, Geo. W., Mechanical Eng..... St. Louis, Mo
Dunbar, E. L., Sec'y & Supt. Water Works..... Bay City, Mich
Dunham, H. F., Consulting Eng., 150 Broadway..... New York, N. Y
Elliot, Chas., City Sup't Water Co..... San Francisco, Cal
Ellis, Geo. A., Civil Eng..... Boston, Mass
Ellis, Robert N., Sup't Water Works..... Jacksonville, Fla
Elmer, Howard, Pres't Sayre Pa. Water Co..... Waverly, N. Y
Elwes, R. Gervase, Civil & Consulting Eng..... London, England
Espy, B. M., Sec'y & Treas. Water Co..... Wilkesbarre Pa
Fanning, J. T., C. & C. Eng., Gt Northern R.R. bldg..... St. Paul, Minn
Farnum, Peter E., Pres't Water Works Co..... Port Jervis, N. Y

Fish, J. B., Sup't Providence Gas & Water Co.....Scranton, Pa
Fitzgerald, Desmond, C. E. & Sup't Water Dep't.....Boston, Mass
Foote, C. M., Civil Eng., 309 Nicollet ave.....Minneapolis, Minn
Forbes, Murray, Sup't & Sec'y Irwin Water Co.....Greensburg, Pa
Fritchman, W. H., Sup't Water Co.....Peoria, Ill
Frost, E. W., Sup't Water Works.....Colorado Springs, Colo
Fry, D. C., 511 Lafayette St.....Jacksonville, Ill
Fuller, F. L., Constructing Eng., 12 Pearl St.....Boston, Mass
Gaines, A. B., Pres't Water Co.....Hot Springs, Ark
Gardner, L. H., Sup't Water Co.....New Orleans, La
Gerecke, F. W., Mechanical Eng., Dickson M'f'g Co.....Scranton, Pa
Geyelin, E., Hydraulic Eng.....Philadelphia, Pa
Gibson, Wm. jr., Publisher Engineering Record.....New York, N. Y
Gleason, J. F., Sup't Water Works.....Joliet, Ill
Glore, W. H., Sup't Water Works.....Covington, Ky
Glover, Albert S., Hersey Mfg. Co.....Boston, Mass
Goodnow, W. T., Constructing Eng. Electric Light Co.....Lebanon, Ky
Gow, R. M., Sup't Water Works.....Medford, Mass
Gray, L. E., Sup't Water Works.....Albany, Oregon
Griffin, A. D., Sup't Water Works.....Frankfort, Ky
Guilford, A. J., Mechanical Engineer.....Chicago, Ill
Hague, C. A., Mec. Eng. with H. R. Worthington.....New York, N. Y
Halbach, Jacob, Sec'y Water Board.....Lansing, Pa
Hamilton, W. S., Sup't Water Works.....Youngstown, Ohio
Hanley, P. M., Sup't Water Works.....Fort Madison, Ia
Hannah, Jos. E., Eng. and Sup't Water Works.....Winnepeg, Can
Harlow, Geo. R., Constructing Engineer.....Pittsburgh, Pa
Harlow, James E., Con. Engineer, 411 Wood St.....Pittsburgh, Pa
Harrington, W. K., Sup't Water Works.....Green Bay, Wis
Harris, W. T., Sec'y and Treas. Water Works Co.....Jackson, Tenn
Harrison, H. H., Sup't Water Works.....Stillwater, Minn
Hawkes, Henry, Water Purveyor.....Brooklyn, N. Y.
Hawkins, Rob't, Ch'f Engr. 68th St., Water Works.....Chicago, Ill
Hawley, John B., Constructing Engineer.....St. Paul, Minn
Haynes, Jos. E., Pres't Aqueduct Board.....Newark, N. J
Heermans, H. C., Sup't Water Works Co.....Corning, N. Y
Henion, J. W., 309 Nicollet Ave.....Minneapolis, Minn
Henderson, Wilsom, Sup't Water Works.....Peterborough, Ont
Herdic, Jas. P., Water Works Contractor.....Williamsport, Pa
Hering, Rudolph C. E., 277 Pearl St.....New York, N. Y
Hermany, Charles, Chief Engineer Water Works.....Louisville, Ky
Hill, John W., Mech. Eng., 22 Glenn B'ld'g.....Cincinatti, Ohio
Hillyer, Geo., Water Commissioner.....Atlanta, Ga.
Hinshaw, G. W., Sec'y & Treas., Water Works.....Winston, N. C.
Hodgkins, H. C., Contractin Engineer.....Syracuse, N. Y
Holden, R. G., Sup't Water Works.....Nashua, N. H
Holland, D. L., M. E.....Sarota Springs, N. Y
Holly, Frank W., Mechanical Engineer.....Lockport, N. Y
Holman, M. L., Water Commissioner.....St. Louis, Mo
Holme, Richard, Sec'y and Sup't Water Co.....Denver, Col
Holme, Richard, Jr., Cashier Water Co.....Denver, Col
Hood, Charles, Sup't Water Works.....Burlington, Ia

Hooper, Thomas N., Chief Engineer Water Works.....Davenport, Ia
Hornung, Geo., Civil Engineer.....Newport, Ky
Howland, A. H., Constructing Engineer.....Boston, Mass
Jackson, F. W., Sup't Water Works.....Oak Park, Ill
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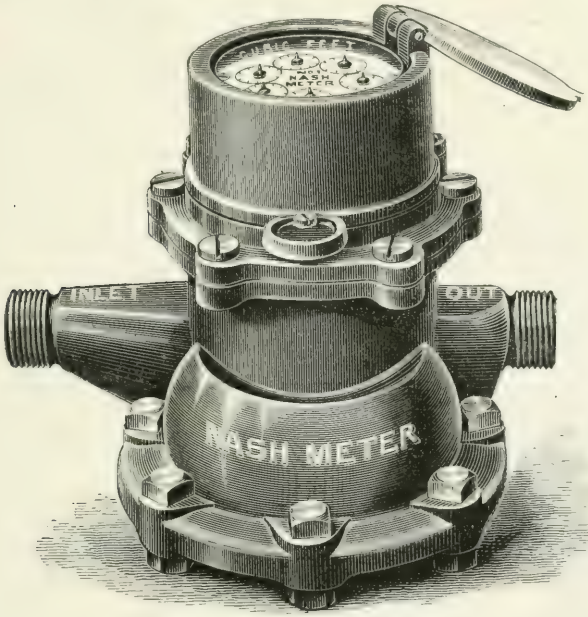

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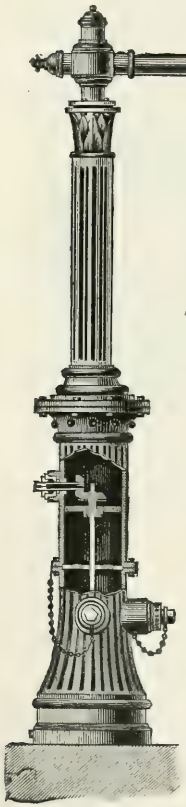

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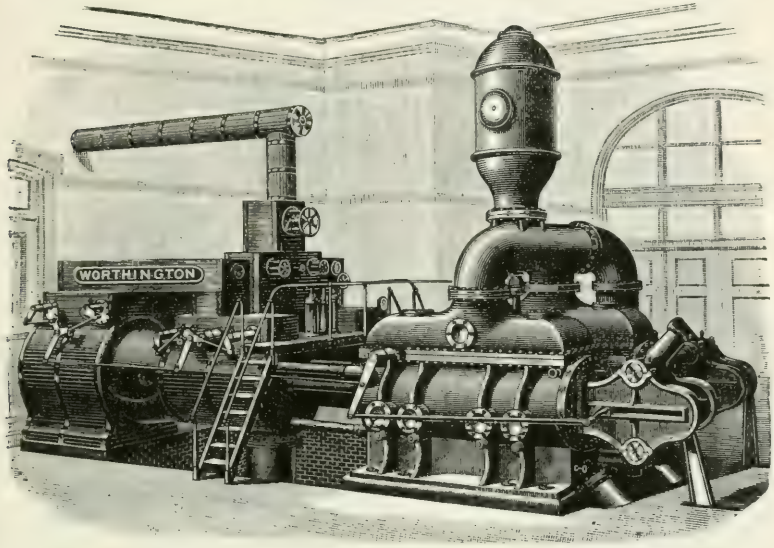

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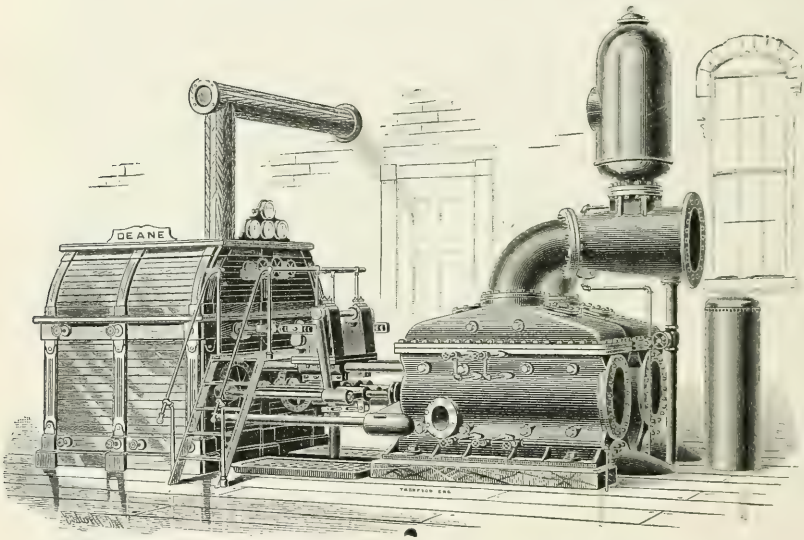

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Place.	Year of Test.	Capacity of Engine Tested.	Duty.	Name of Expert.
Saratoga Springs, N. Y...	1882	5,000,000	112,899,983	Prof. D. M. Greene and John W. Hill, M. E.
Saratoga Springs, N. Y...	1883	5,000,000	127,170,000 106,838,000	Prof. Charles T. Porter.
Columbus, Ohio.....	1884	10,000,000	115,400,000	Prof. T. C. Mendenhall.
Burlington, N. J.....	1884	1,500,000	77,770,400	H. P. M. Birkinbine, C. E.
Buffalo, N. Y.....	1885	15,000,000	125,907,297	John W. Hill, M. E.
Jackson, Mich.	1886	4,000,000	111,781,072	Charles Christopher, Ch. Eng.
Leavenworth, Kan.....	1886	4,000,000	110,478,000	Thos. J. Whitman, C. E.
Kalamazoo, Mich.....	1886	3,000,000	102,728,884	John W. Hill, M. E.
Norfolk, Va..	1886	5,000,000	95,420,216	Wm. Wright, Ch. Eng.
Chicago, Hyde Park.....	1886	12,000,000	110,632,166	Chas. Hermany, C. E.
Beverly, Mass.....	1887	2,000,000	Capacity Test.	Walter H. Sears, C. E.
Lima, Ohio.....	1887	3,000,000	110,482,946	J. D. Cook, C. E.
Erie, Pa.....	1887	5,000,000	122,309,829	Frederick A. Scheffler, M. E.
Chicago, No. Side Station.	1887	12,000,000	102,583,585	Prof. Robert H. Thurston. J. S. Coon, C. E. James N. Warrington, C. E.
Philadelphia, Penn.....	1888	20,000,000	125,022,730	John E. Codman, C. E.
Washington, D. C..... (East Engine.)	1888	2,500,000	101,772,977	G. W. Baird, Passed Asst. Eng. U. S. Navy.
Washington, D. C..... (West Engine.)	1888	2,500,000	101,183,587	
Boston, Mass	1888	8,000,000	109,421,100	Wm. Jackson, City Eng.
Port Huron, Mich.	1888	5,000,000	102,638,623	Henry Burton, Asa R. Cole.
Chicago, Town of Lake...	1889	12,000,000	108,600,000	Benzette Williams, C. E.
Buffalo, N. Y.....	1889	20,000,000	122,255,512	Louis H. Knapp, Supt. and E.
Springfield, Ohio	1889	5,000,000	113,395,447	Charles A. Bauer, C. E.
Saratoga Springs, N. Y...	1889	8,000,000	117,936,698	Prof. D. M. Greene.
Dayton, Ohio.....	1889	10,000,000	124,782,157	Arthur Giesler, M. E.
Brantford, Ont.....	1890	2,000,000	96,735,491	Thos. Worswick, M. E.
Nashville, Tenn...	1890	10,000,000	117,829,420	Geo. Reyer, Supt. W. W.

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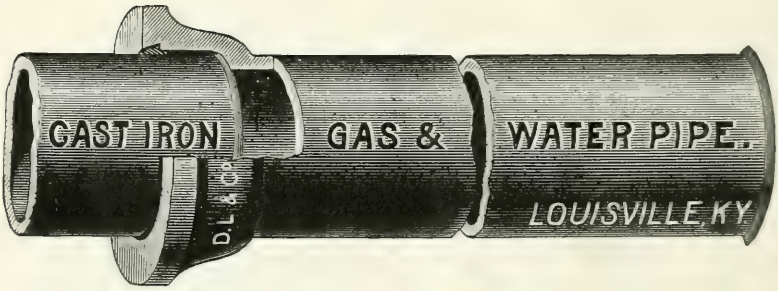

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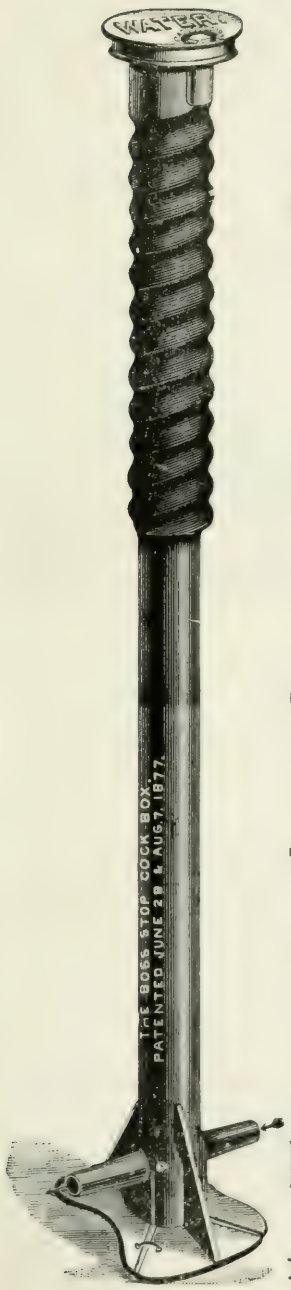

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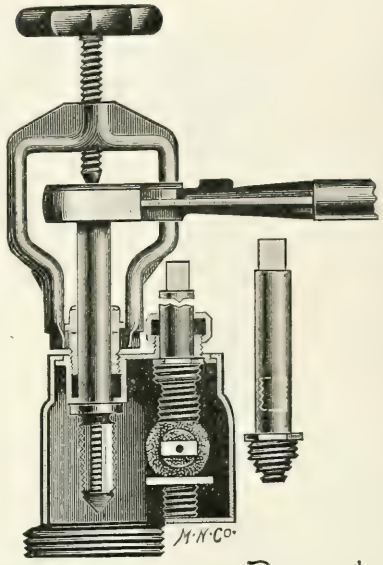
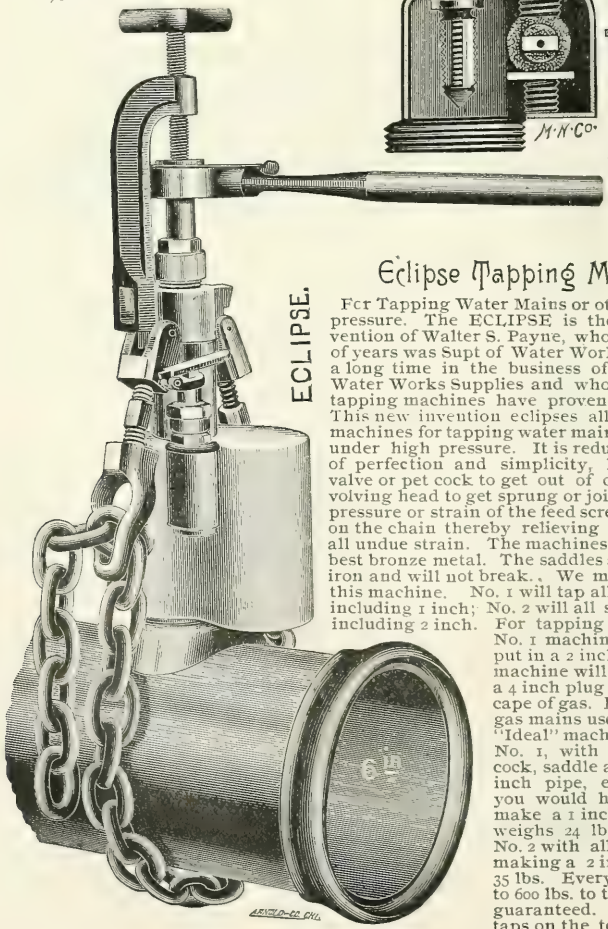
This machine taps a pipe on the top or side, or at any angle desired. We make five sizes, No.0, which taps ¼-inch, ⅜-inch and ½-inch; No. 1 taps ⅜-inch, ½-inch, ⅝-inch, ¾-inch and 1-inch; No. 2 taps all sizes from ⅜-inch to and including 1¼-inch; No. 3 taps all sizes from ⅜-inch to to 1½-inch; No. 4 taps all sizes from ⅜-inch to 2-inch.





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For Tapping Water Mains or other Pipes under pressure. The ECLIPSE is the very latest invention of Walter S. Payne, who for a number of years was Supt of Water Works and has been a long time in the business of manufacturing Water Works Supplies and whose other patent tapping machines have proven such a success. This new invention eclipses all other tapping machines for tapping water mains or other pipes under high pressure. It is reduced to the acme of perfection and simplicity, having neither valve or pet cock to get out of order and no revolving head to get sprung or joint to leak. The pressure or strain of the feed screw pulls directly on the chain thereby relieving the machine of all undue strain. The machines are made of the best bronze metal. The saddles are of malleable iron and will not break. We make two sizes of this machine. No. 1 will tap all sizes up to and including 1 inch; No. 2 will all sizes up to and including 2 inch. For tapping gas mains the No. 1 machine will tap and put in a 2 inch plug. A No. 2 machine will tap and put in a 4 inch plug without the escape of gas. For low pressure gas mains use our "Daisy" or "Ideal" machine. Our Eclipse No. 1, with 1 ince tap and cock, saddle and chain for 6 inch pipe, everything that you would have to carry to make a 1 inch tap complete weighs 24 lbs. Our Eclipse No. 2 with all appliances for making a 2 inch tap weighs 35 lbs. Every machine tested to 600 lbs. to the sq. inch and guaranteed. This machine taps on the top or side or at any angle desired. Also manufacturers of Corporation Cocks and other Water Works Supplies.

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WATER TAPPING MACHINE
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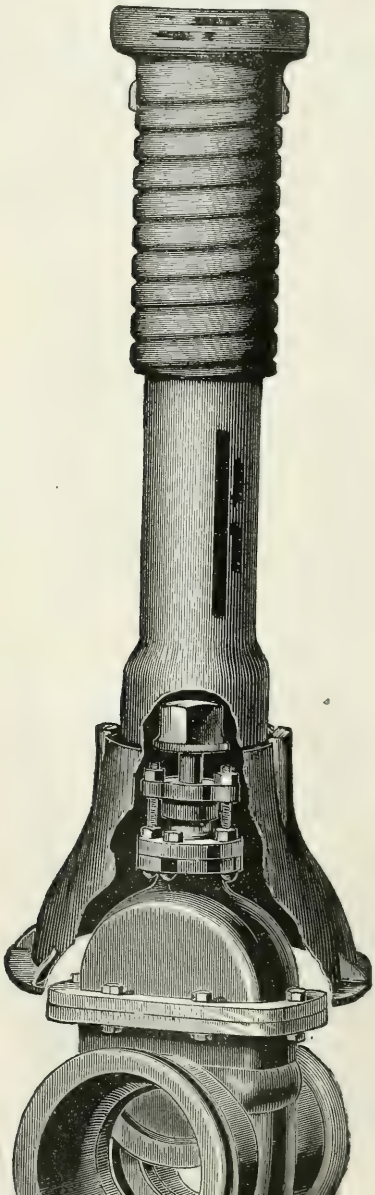

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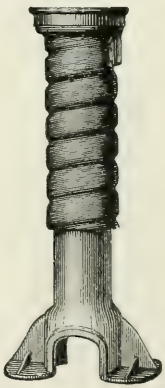

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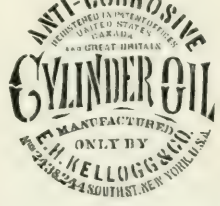
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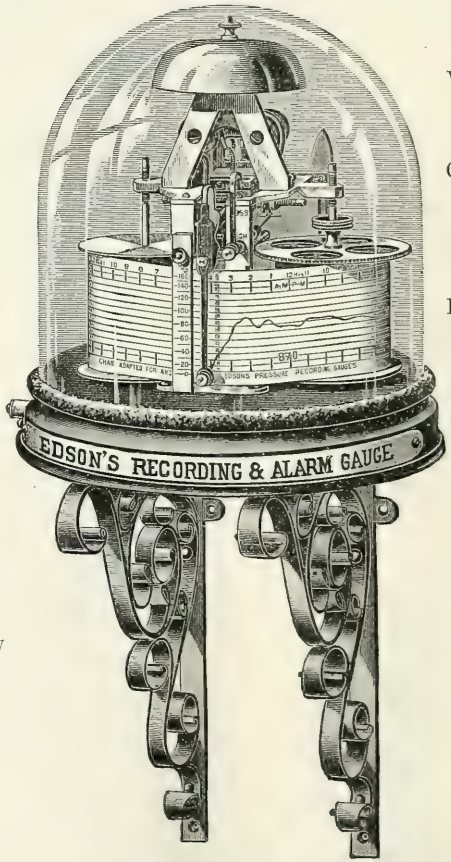

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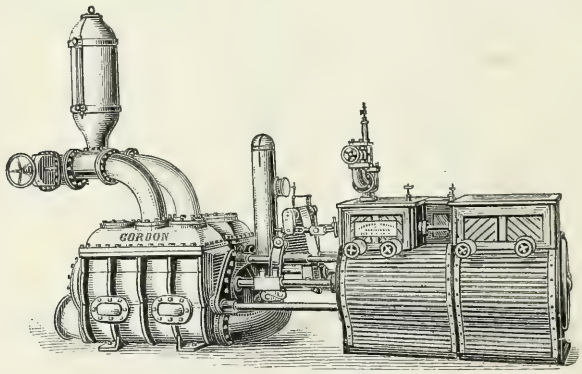

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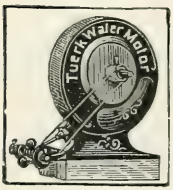
Water 

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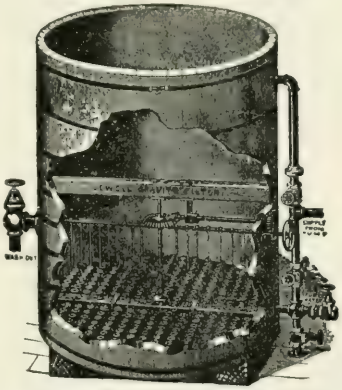

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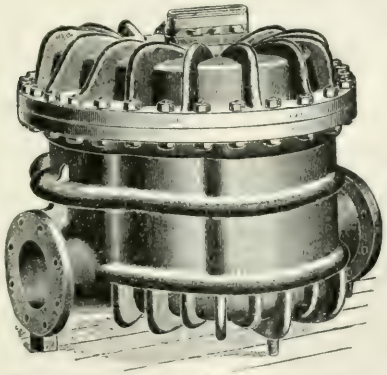

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REPORT OF PROCEEDINGS

OF THE

TWELFTH ANNUAL MEETING

OF THE

American Water Works Association,

HELD AT THE

Metropolitan Hotel,

New York City, May 17-20, 1892.

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ADVERTISER ASSOCIATION PRINT,
1892.

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TWELFTH ANNUAL MEETING

OF THE

AMERICAN WATER WORKS ASSOCIATION,

HELD AT THE METROPOLITAN HOTEL,

NEW YORK CITY, N. Y., MAY 17-19, 1892.

FIRST DAY.

MORNING SESSION, Tuesday, May 17th, 1892.

The President called the meeting to order at 11 o'clock, a. m.

THE PRESIDENT.—The first order of business is the calling of the roll. If any member knows of another member present at the meeting, but not in the room, he will please answer for him.

The Secretary called the roll, and the following gentlemen responded, or were known to be present :

ACTIVE.

Alexander, W. A., Sup't Penna. Water Co ..... Wilkinsburg, Pa
Ayres, H. W., C. E. Water Works ..... Hartford, Conn
Ayres, Sylvanus, Jr., Mgr. Water Works ..... Bound Brook, N. J
Babcock, S. E., C. E. Water Works. ..... Little Fall, N. Y
Benzenberg, G. H., Ch'f Eng. Water Dep't ..... Milwaukee, Wis
Bolling, Chas. E., Sup't Water Works ..... Richmond, Va
Bond, Joseph A., Ch'f Eng. Water Dep't ..... Wilmington, Del
Bristol, W. H., Recording Gauge Co ..... Hoboken, N. J
Brown, Calvin S., with Hersey Meter Co ..... Boston, Mass
Brown, Milton A., Sup't Water Co ..... Perth Amboy, N. J
Brush, Chas. B., C. E. & Sup't Water Works ..... Hoboken, N. J

Cahill, Stephen A., Sup't Water Works.....Manistee, Mich
Carlin, Phil., Sup't Water Works.....Souix City, Ia
Case, L. N., Sec'y Water Department.....Detroit, Mich
Caulfied, John, Sec'y Water Board..... St. Paul, Minn
Chase, John C., C. E. & Sup't Water Works.....Wilmington, N. C
Clayton, R. M., City Engineer.....Atlanta, Ga
Goggeshall, R. C. P., Sup't Water Works.....New Bedford, Mass
Conant, Whitney, Sec'y Water Co.....Long Branch, N. J
Croes, J. J. R., Consulting Eng., 13 William St.....New York, N.Y
Davis, F. A. W., Pres't & Treas. Water Co.....Indianapolis, Ind
Decker, J. H., with H. R. Worthington, 86 Liberty St., New York, N. Y
Denman, A. N., Sec'y Water Co.....DesMoines, Ia
Diven, J. M., Sup't Water Works Co .....Elmira, N. Y
Donahue, J. P., Vice Pres't & Sup't Water Co.....Davenport, Ia
Doran, Hugh F., Sup't Water Works.....Port Huron, Mich
Dunbar, E. L., Sec'y & Sup't Water Works.....Bay City, Mich
Dunham, H. F., Consulting Eng., 150 Broadway.....New York, N. Y
Espy, B. M., Sec'y & Treas. Water Co.....Wilkesbarre, Pa
Farnum, Peter E., Pres't Water Works Co.....Port Jervis, N. Y
Forbes, Murray, Sup't & Sec'y Irwin Water Co.....Greensburg, Pa
Fuller, F. L., Constructing Eng., 12 Pearl St.....Boston, Mass
Gardner, L. H., Sup't Water Co.....New Orleans, La
Glore, W. H., Sup't Water Works .....Covington, Ky
Glover, Albert S., Hersey Mfg Co.....Boston, Mass
Griffin, A. D., Sup't Water Works.....Frankfort, Ky
Guilford, A. J., Mechanical Engineer.....Chicago, Ill
Harlow, James E., Con. Engineer, 411 Wood St.....Pittsburgh, Pa
Herring, Rudolph, C. E., 277 Pearl St.....New York, N. Y
Holden, H. G., Sup't Water Works.....Nashua, N. H
Holly, Frank W., Mechanical Engineer.....Lockport, N. Y
Hood, Charles, Sup't Water Works.....Burlington, Ia
Jones, A. J.....New Brunswick, N. J
Jones, B. F., Sup't Water Co.....Kansas City, Mo
Keeler, H.E., Director Charlestown, Ill., Water Co.....Chicago, Ill
Kelley, John C., Director Water Works.....Brooklyn, N. Y
Kuehn, Jacob L., Sup't Water Co.....York, Pa
Kuhnen, N., Pres't Water Co.....Davenport, Ia
Leeds, Albert R., Consulting Chemist .....Hoboken, N. J
Linneen, P. H., Mechanical Engineer.....Chicago, Ill
McAlpine, A. H., Chief Engineer Water Works.....Columbus, O
McElroy, Samuel, Civil Eng., 40 Johnson St .....Brooklyn, N. Y
Mather, Edmund, Sup't Water Works.....Harrisburg, Pa
Milne, Peter, Editor Fire and Water, 14 Cortland St., New York, N. Y
Milner, W. J., Sec'y and Sup't Water Works.....Birmingham, Ala
Mines, W. W., Sup't Water Works.....Camden, N. J
Molis, Wm., Sup't Water Works.....Muscatine, Ia
Monjeau, C. Hydraulic Eng., Commercial Gazette Bldg.....Cincinatti, O
Neville, Thos. J., Water Registrar.....Rochester, N. Y
Nicholas, C. M., Sup't Water Works.....Madison, Wis
Ogden, John L., Chief Engineer Water Dept.....Philadelphia, Pa
Owen, James, Sup't Water Works.....Montclair, N. J
Page, J. B., Sup't Water Works.....Lynchburg, Va
Phipps, E. H., Sup't Water Works, 78 Crown St.....New Haven, Conn

Pierson, Geo. H., Consulting Engineer, 74 Broadway..New York, N. Y
Priddy, Chas. N., Secretary and Sup't Water Works.. ...Leadville, Col
Richards, W. G., Sup't Water Works.....Atlanta, Ga
Rider, W. B., Hydraulic Engineer..... . S. Norwalk, Conn
Robertson, Geo. H., Sup't Water Works.....Yarmouth, N. S
Ruggles, W. W., Chief Engineer Water Dept ....Jersey City, N. J
Ryle, Wm., Sup't Water Co.....Paterson, N. J
Sawyer, J. T.,President Water Co..... ... ...Waverly, N. Y
Schrop, Ira S., Supt Water Works ..... .South Bend, Ind
Sheppard, F. W., "Fire and Water,"14 Cortland St....New York, N. Y
Shannahan, Wm. E., Secretary Water Co..... .....Easton, Md
Smith, Anthony P., Supervisor Water Works... .....Newark, N. J
Snow, Eug. J., Thompson Meter Co... .....New York, N. Y
Steben, B. F., Secretary and Treasurer Water Dept.....Brockville, Ont
Taylor, John W., Supt Water Works .. ..Newcastle, Pa
Tilden, Jas. A., Mechanical Engineer..... .....Boston, Mass
Tracy, Thos, H., Supt. Water Works..... ... London, Ont
Tucker, A. A., Supt. Water Works .....Memphis, Tenn
Wagner, Louis J., Supt. Water Works..... .. .. Rome, Ga
Wanner, P. D., President Windsor, Pa., Water Co .....Reading, Pa
Watts, W. H., Supt. Water Works... ....El Paso, Texas
Wilkerson, J. H.,, Supt. Water Works .....Bowling Green, Ky
Wills, E. S., Supt. Water Co.... ....Atchison, Kan
Wingfield, N., Chief Engineer Water Works.... .. Chattanooga, Tenn
Woodruff, Timothy, Supt. Water Works.....Bridgeton, N. J

ASSOCIATE.

Brass and Iron Works Co., The.. .....Fostoria, Ohio
Canton Water Works..... .....Canton, Ohio
Chapman Valve Manufacturing Co..... .. Indian Orchard, Mass
Deane Steam Pump Co.... ....Holyoke, Mass
Deutsch, Wm. M., Pres. Nat'l WaterPurifying Co., 145 Broadway, New York
Eddy Valve Manufacturing Co.....Waterford, N. Y
Edson, Jarvis B., No. 87 Liberty St... .....New York, N. Y
Fisher Governor Co., Governors.....Marshalltown, Iowa
Brass and Iron Works, Michigan..... .....Detroit, Mich
Gordon Steam Pump Co... ....Hamilton, Ohio
Hersey Manufacturing Co..... .. ..Boston, Mass
Hinds, A., Jr., Tuerk Hydraulic Power Co., 39 Dearborn St. .Chicago, Ill
Holly Manufacturing Co., Pumping Machinery..... ..Lockport, N. Y
Illinois Malleable Iron Co .... Chicago, Ill
Kellogg, E. H. & Co., No. 243 South St..... .....New York, N. Y
Mueller, H., Manufacturing Co..... .....Decatur, Ill
National Meter Co., 287 Broadway..... .....New York, N. Y
National Tube Works Co.... ....McKeesport, Pa
Norfolk Water Works, H. N. Smith, Supt. .....Norfolk, Va
Fairbanks & Co., 311 Broadway.....New York, N. Y
Payne, Walter S... ....Fostoria, Ohio
Rensselaer Manufacturing Co..... ... Troy, N. Y
Rouse & Hills Co., 57 Frankfort St.... .....Cleveland, Ohio
Thompson Meter Co., 59 York St.....Brooklyn, N. Y
Union Water Meter Co..... ....Worcester, Mass

Walworth Manufacturing Co.....Boston, Mass
Wood, R. D. & Co., 400 Chestnut St.....Philadelphia, Pa
Worthington, H. R., 86 Liberty St.....New York, N. Y

THE PRESIDENT.—The next order of business is the reading of applications for membership.

The Secretary then presented the following applications :

ACTIVE MEMBERSHIP.

Charles W. Calkine, Sup't Water Works.....Rockford, Ill.
C. L. John, Sup't Water Works .. ..Mt. Carmel, Pa.
A. A. Tucker, Sup't Water Works.....Memphis, Tenn.
Thomas Watkins, Manufacturer .....Johnstown, Pa.

ASSOCIATE MEMBERSHIP.

Toledo Water Works.....Toledo, Ohio.
Ross Valve Company.....Troy, N. Y.

Mr. Richards moved that the Secretary cast the ballot of the Association for the gentlemen and companies named.

Motion seconded and carried.

The Secretary thereupon cast the ballot, and the President declared the applicants duly elected.

THE PRESIDENT.—The next order of business seems to fall on the President. He then his address, as follows :

PRESIDENT'S ADDRESS.

Gentlemen of the American Water Works Association :

Another year with its cares and labors, with its disappointments and pleasures has rolled by, and again we meet together in convention. Again old friends join hands in hearty greeting, and extend to new members the cordial hand of welcome. We to-day come together for our twelfth annual convention; the large number here present and the excellent programme, both for our business sessions and our social enjoyment, are conclusive evidence that the spirit of progress in our Association is not lagging.

The hand of the Destroying Angel has not been idle since our last meeting. Four members have been taken from our ranks, never to meet with us again. But when we consider the few gaps made in our ranks during the twelve years of our association together, we have cause to congratulate ourselves on the healthfulness of our calling; or to marvel at the hardiness of the men who have engaged in it. Few though our losses be, they are not the less sad. We can afford to spare none from our ranks, least of all, it always seems, those who are taken. We know

not who will be called next. Therefore let us so live together that when one of our members is called we may have no act of ours to regret and to make to us more bitter the sorrow of the common loss. We are banded together in a noble cause, to protect the health, the very existence almost, of the people dwelling in the cities and towns of a whole continent; let us always keep this object in view and work together for its accomplishment. Our little differences of opinion, our petty jealousies, are as nothing when we contemplate the importance of the work that devolves upon us.

Twelve years ago a few resolute men made, in St. Louis, the beginning of this Association. Let us measure the future by the past, let us imagine an equal progress for the next twelve years, and we have to contemplate an association not excelled in importance by any in the world.

Twelve years ago, when the beginning of this Association was made, the water supply business was in its infancy. At that time one could, almost, count on his fingers the number of engineers whose energies were exclusively devoted to water supply; to-day there is a considerable army, and the roster contains the names of some of the most prominent engineers of the age, whose whole lives and energies have been devoted to the betterment of the supply of the greatest necessity of mankind.

These twelve years have witnessed great growth and changes in the business of supplying water. During this period nearly as many water works have been built as during the entire century preceding it. And the improvement in methods and appliances has been in almost equal proportion. The many new inventions in water works machinery and appliances which have been brought out during this period are too well known to need mention here; suffice it to say that they make the old methods seem incredible.

Although the past twelve years have been years of great progress, nevertheless they have developed some evils. A too rapid growth is seldom a healthy growth; the growth of water works is no exception to this rule. During the flush times of water works building, when water works securities may be said to have been fashionable—when little else was necessary than securing a franchise and printing bonds to insure their sale—many works were built where the conditions did not warrant them, where they were not needed. Default in payment of interest on bonds issued for their construction soon made manifest the impropriety of such works. The thing to be deplored is not that these towns secured a water supply—which is undoubtedly a good thing for the towns—but the fact that the default on these bonds brought such securities into bad repute, greatly to the detriment of legitimate enterprises.

Many instances have arisen of late of attempts on the part of municipalities to force corporations supplying them with water to sell their plants to the municipalities at prices which would mean great loss to the companies. The injustice of this seems to me obvious. These corporations came forward and furnished these places with a water supply when they were unable or unwilling to provide one for themselves—indeed, in many instances at their solicitation. They built, probably, just such works as the municipalities would have built themselves. It is not their fault that an unforseen growth of the town has rendered portions of their works inadequate and useless, that material and appliances have greatly

improved, that prices were at the time of construction greater than now. Had the municipalities built the works themselves at the same time all these conditions would have had to be met by them. It is undoubtedly true that any water works that was built ten or twenty years ago can be duplicated now at a much less cost, owing to the lower prices for labor and material and the improvement in methods of construction. But this fact does not make it seem right that corporations which built works then, and which have in the meantime supplied the cities or towns with water, should be compelled to lose by these changes. Either the cities and towns which have been thus supplied must have built for themselves works under the same disadvantageous circumstances, or have been been without a water supply; in which latter case they would probably never have reached their present size and importance.

The interests of a water company and the city or town which it supplies are almost identical. Unless the town is prosperous, certainly the water company cannot be; and, on the other hand, the progressiveness of the water company determines, to a considerable extent, the prosperity of the town. Under these circumstance it would seem that harmony and not discord should prevail. For the discords that prevail possibly, in many cases probably, the companies are to blame. If they are not progressive, if they are not willing to at least keep pace with the growth of the town, certainly the fault is theirs. But, after going through the discouraging struggle which is almost always sure to mark the first few years of a water works, after carrying on the works during the years that the people are getting educated to an appreciation of a good water-works system and to its use, then to have to lose the fruit of all these labors does not seem justice. To invent or devise a remedy for these discords is within the scope of and would be a grand work for this Association. Mr. Tubbs will, in his paper entitled "Particulars in which municipal officers should protect the municipal corporation in granting water works franchises to private water companies," undoubtedly point out to us how franchises may be granted to avoid these difficulties; but this will not, unfortunately, apply to the one thousand or more franchises already granted.

Much as we have reason to congratulate ourselves on our largely attended meetings and on our long and steadily growing membership roll, there is still much to be desired. On checking in the "Manual of American Water Works" the names of places having a water supply that were not represented in our Association, I was struck with the comparatively few that were represented. There is to-day scarcely a town of any considerable size on the North American Continent that has not a public water supply; the list comprises over two thousand cities and towns. There are represented in our Association only about two hundred, or one-tenth of the whole number. Here is room for grand missionary work. Of the eighteen hundred works not represented, fully one-third—or six hundred—are places of a size that can well afford a membership in the Association and to send a representative to its conventions; indeed, they can hardly afford not to do so. How shall we get them in? How persuade them to do what is manifestly to their advantage? This must be the work of the individual members of the Association. Year after year our annual invitations have gone out with our President's appeal, to these towns, with but meagre results. To bring

them in, each member must use his personal influence on his neighbors—if our Past President, Mr. Bull, will allow me to assume that we have any neighbors in our "lonesome calling."

I well remember the pride and satisfaction I felt when, at the Denver convention, I heard read the names of three candidates whom I knew I had induced to join us. I was rather a young member then, but for a little while I felt that I was almost as big a man even as Decker. Now I am confident that if any of you will induce some water-works man to send in his name you will feel as great a satisfaction. You will feel you have done your duty to your Association and also to the man whose name you cause to be presented.

There is another duty which we all owe to the Association and in which I fear many of us are derelict. I refer to the preparing of papers for the conventions. We are associated together for the *interchange* of ideas and experiences; it is not intended that any member shall come year after year to receive information and never to impart any in return. Or, as one gentleman expressed himself last year, "come in an entirely receptive state of mind." It is the duty of each, as a member of the Association, to give to the others the benefit of his experiences; it is the very object for which we are associated together. Members, when solicited to write a paper, say, "I have had no experience worth relating." They do not stop to consider that experiences which to them do not seem "worth relating" may be worth a great deal to other members. The idea of a water-works superintendent or engineer that has not had experiences is incredible. The little every-day experiences will make up a paper equally interesting with the scientific thesis of the expert engineer or chemist; both have their places in our daily work and should appear side by side in our proceedings.

Papers descriptive of water-works are both interesting and instructive and should appear in all our annual reports.

There is room, also, in our reports, for definite knowledge on water-works problems, either tabulated or otherwise arranged for ready reference. In fact, our reports should be among the standard, if not preeminently *the* standard on hydraulics. They should be the authority on such questions as the flow of water in mains, or services; and other water-works problems. Some such literature our present programme promises to supply.

We now have a very able committee at work, trying to fathom the causes which lead to the contamination of our water supplies. When their labors are completed and the causes, or some of them, are established it will devolve upon us to seek the remedies for them. In this work "Mechanical Filtration" will probably aid us; though it would seem to be better to prevent contamination rather than to apply a remedy after it has occurred.

With the growth of our country, particularly of our cities, the danger of contamination of our streams and lakes, which are, in many cases, necessarily the source of our water supplies, is rapidly increasing. How to stop this danger is one of the problems we must soon grapple with. Whether to turn our attention to improved methods of sewage disposal and attempt to educate the people to their adoption and thus preserve the purity of our sources of supply; to seek redress by restrictive legislation, thereby compelling the people to keep pure the water they must drink.

or to turn our attention to purifying the contaminated supplies. These are the questions we must decide.

The programme of this meeting, both for its business sessions and its social reunions and pleasure excursions, is a very attractive one and it very wisely and sensibly gives us three clear days in which to attend to the business of the convention. The ever-vexed meter question is conspicuous by its absence; in all other respects the list seems most complete. Possibly the rest will do the meter qustion good, as it must be nearly exhausted by this time.

It is pleasing to note the provisions which our Committee on Local Arrangements has made for the entertainment of the ladies. It is a much needed encouragement to that most desirable feature of our conventions, the attendance of the ladies.

I cannot close without speaking of one other feature which is fast coming into favor and which is a most desirable feature—the exhibition of water-works appliances. The interest in this feature, both on the part of the exhibitors and of the active members, has shown rapid growth for the past few years. It is a feature that cannot receive too much encouragement. It gives to many members an opportunity to examine new and improved appliances and to have them explained, which otherwise they would never have.

I feel that I have taken up already too much of the short time allowed us to listen to and discuss the many excellent papers on our programme. I thank you, gentlemen, for the patient attention which you have given me and for the great, though little deserved, honor you have conferred upon me by choosing me to preside over the deliberations of so distinguished a body of men.

The reading of the address was concluded amid applause.

The President.—The next order of business is the report of the Executive Committee. The Committee so far has had no meeting. Are there any members of the Committee here? The Committee will then meet immediately after adjournment in room 226.

The President.—The next order of business will be the report of the Secretary and Treasurer, but the report cannot be acted upon until after the meeting of the Executive Committee; likewise the report of the Finance Committee.

The President.—The next order of business will be the Reports of Special Committees.

The Secretary.—Mr. President, there is but one Special Committee to report, that of the Committee on Vegetable and Animal Growth affecting Water Supplies; of which Prof. Leeds, of Stevens Institute, Hoboken, is

Chairman. The Professor is not here. I have received a letter from him in which he says that he is not prepared to make a full report; and I judge he has a partial report to make. He is not here this morning, but will probably be here during the meeting.

The Secretary then read the following invitations to visit the new Engine House and Pumping Station of the City of Brooklyn, Ridgewood Pumping Station, East New York, Long Island, and from the Board of Managment of the Engineers' Club of New York City, to make use of their rooms.

The Secretary.—As a member of that club, and I think I can also speak for the President, who is a member of the club, we will be pleased to have you make use of the rooms of the Club during your stay in the city. They are at No. 10 West 29th street.

The President.—The Local Committee have availed themselves of the invitation to visit the Brooklyn Engine House and Pumping Station, and we will go there on Friday. What is your pleasure in regard to the invitations?

Mr. Lowrie.—I move the invitations be accepted with thanks. Seconded by Mr. Babcock. Motion put and carried.

The President.—There seems to be no further business.

Mr. Brown.—Before we adjourn, I would like to make a motion. I see by the programme that Thursday is set apart for the election of officers; and I would move you that these officers be selected by the Convention and balloted for at that time, instead of being nominated by a Committee, as heretofore. I would like to hear an expression from the members on that subject.

Mr. Wills.—I move the question be postponed until this afternoon. The acoustic properties of this room are very poor. The gentlemen a few seats back cannot hear a word that is being said in front. I suggest that the Committee having the matter in charge move the seats closer to the desk this afternoon; and

there will be more men and a fuller meeting to discuss the subject. I approve the motion, but I move its postponement until this afternoon.

Mr. Monjeau.—If you will allow me to speak to a privileged question. I regret exceedingly that I could not hear more than one-third of the President's paper. I do not know whether it would be a proper thing to criticise anybody for this. Several gentlemen who have left the room told me they could not hear anything.

The President.—This is a difficulty we will try to have remedied before the afternoon session. We can certainly move the chairs closer, and by closing the windows, can shut out most of the noise.

Mr. Wagner.—I doubt very much if that will remedy the trouble. I tried to listen very carefully to the reading of your paper, Mr. President, but could hear but little of it. I consoled myself with the fact that I could read it when in print. A friend of mine has suggested that the platform could be moved to the end of the room, getting as far away from the side near the street as possible, and then bringing the chairs closer, we may be able to hear better. I hope the Committee will make arrangements of some kind to overcome this trouble, and if we cannot do any better, we will have to move out into the exhibition room. I think that would be better than this room.

The President.—The question is on Mr. Wills' amendment.

Mr. Brown.—I move that the matter be brought up at the afternoon session instead of at the present time.

The motion was seconded, put and carried.

The President.—Before we adjourn, I want to say that I hope the delegates will be more prompt this afternoon. It was eleven o'clock before we started this morning, and as we have a good deal of business to get through with, we must be prompt.

Mr. Molis.—I move we reciprocate the invitation of the Engineers' Club, by inviting the members of that

Club to our meeting. They have kindly invited us to their club, and it would be well to extend them the courtesies of our meeting.

THE PRESIDENT.—The motion is that the Secretary be directed, if he has not already done so, and I think he has, to send an invitation to the Engineers' Club, and all its members, to attend our meeting. Carried.

THE PRESIDENT.—There is no further business before the convention, and we will adjourn until the afternoon session, which will be 2:30, prompt.

Adjourned.

AFTERNOON SESSION—2:30 P. M.

President called the meeting at 2:45 p. m.

THE SECRETARY.—If there are any gentlemen present who have not had their badges I will be glad to give them to them.

THE PRESIDENT.—First order of business will be the postponed business of this morning—the report of the Executive Committee.

THE SECRETARY.—Mr. President, a moment before preceding with that, I have some applications for membership.

THE PRESIDENT.—Applications for membership always take preference.

The followning applications were then presented:

For active membership—Jay Chatham, Superintendent Water Works, Iowa City, Iowa.

For associate membership—William H. Bristol, Bristol Recording Pressure Gauge Co,, Hoboken, N. J.

It was moved that the Secretary cast a ballot of the Association in favor of the admission to membership of these applicants. Carried.

THE SECRETARY.—According to the vote just determined I hereby cast the vote of the Association for the applicants named.

THE PRESIDENT.—I declare the applicants elected to membership.

THE PRESIDENT.—We will now proceed with the unfinished business of the morning—the report of the Executive Committee.

The Secretary then read the report of the Executive Committee, as follows:

REPORT OF EXECUTIVE COMMITTEE.

NEW YORK, May 17th, 1892.

To the Members of the American Water Works Association:

GENTLEMEN—Your Executive Committee would respectfully report:

First.—That we considered the resignation of the Secretary and Treasurer, which was tendered in writing July 1st, 1891, which has since been held in abeyance owing to the fact that the Constitution provides no means of filling the vacancy, and would recommend that the incumbent be requested to retain the position until the close of this meeting, or until his successor shall be duly elected.

Second.—That we have fixed the salary of the Secretary and Treasurer at the sum of $500 for the past year.

Third.—That the report and books of the Secretary and Treasurer having been examined by the Finance Committee and found correct, we respectfully approve the same.

Fourth.—That all members three years or more in arrears for dues who shall not appear at this meeting and make payment be dropped from the roll, and should they again apply for membership, that they only be received upon payment of all arrearages.

(Signed.) J. M. DIVEN, President.

ATTEST:—J. H. DECKER, Secretary.

The motion was made that the report be received.

Mr. Gardner moved that the report of the Executive Committee be not only received but adopted. Carried.

THE PRESIDENT.—The next order of business is the report of the Secretary and Treasurer.

The Secretary read the report as follows:

SECRETARY'S REPORT.

To the President and Members of the American Water Works Association:

GENTLEMEN:—I have the honor to submit herewith the twelfth annual report of the Secretary and Treasurer of the Association. Since our last convocation, the grim reaper, death, has made sad inroads upon us, removing from our number four of our active members; to wit: L. Halsey Williams, Secretary and Treasurer, New Castle, Pa., Water Works; Edward Armstrong, Superintendent Allegheny City, Pa., Water Works; Nicholas Kuhnen, President Davenport, Iowa, Water Co., and Charles Elliott, Superintendent Spring Valley Water Co., San Francisco, Cal.

In addition to this loss there have been ten resignations, seven active and three associate, and eight dropped from the roll, six active and two associate; a total loss of twenty-two members.

During the year we have gained by reinstatement, one active member, and thirty-nine new members; thirty-two active and seven associate, a total of forty or a net gain of eighteen. The enrollment to-day shows one honorary, 303 active and seventy-four associate; a total membership of 378.

I would respectfully call your attention to my resignation as Secretary and Treasurer tendered July 1st, 1891, and which could not be accepted at that time as our present constitution provides no way of filling such vacancy in the interim of meetings.

In view of this fact, I would respectfully recommend that a committee be appointed to revise the constitution, so as to provide for such contingencies in the future, and that in such revision they strike out the word "thereafter," where it occurs in the last line of both sections one and two of Article 9. This article has been misunderstood by many of our members and has given rise to some ill feeling.

In stepping aside from an official connection with the Association which I have held for the twelve years of its existence, I beg to return to you, gentlemen, my sincere and heartfelt thanks for the honors conferred upon me and for the hearty good fellowship and many kindly courtesies extended to me. While my official connection is severed, I wish it plainly understood that my love for and interest in the Association remains as ever, and that in the future I shall labor just as hard for its welfare and upbuilding as I have done in the past.

CASH STATEMENT.

Balance on hand last report			$406 15
Received from admission fees	$ 230		
" " Annual dues	1,158		
" " Advertising	292		
" " Sale of proceedings	4	50	
" " " " badges	12	00	1,696 50
Total from all sources			2,102 15

DISBURSEMENTS.

Paid warrant No. 74 in favor of D. J. Marchant, Stenographer, report eleventh Annual Meeting	$100 00

Paid warrant No. 75 in favor Continental Hotel, extra room, eleventh annual meeting	99 05
Paid warrant No. 76 in favor N. A. Miller, engrossing obituary memorial J. G. Briggs	5 00
Paid warrant No. 77 in favor of J. Y. Johnston & Co., for stationery	7 28
Paid warrant No. 78 in favor of A. R. Leeds, expense of examination of waters	150 00
Paid warrant No. 79 in favor C. B. Kirtland for stationery	7 00
Paid warrant No. 80 in favor C. G. Braxmer for ten gold badges	40 00
Paid warrant No. 81 in favor J. Y. Johnston & Co., for stationery	11 75
Paid warrant No. 82 in favor Elmira Advertising Association, printing proceedings elventh Annual Meeting	377 00
Paid warrant No. 83 in favor of J. M. Diven, for postage and sundry office expense	64 47
Paid warrant No. 84 in favor J. H. Decker, postage and office expense	76 80
Paid warrant No. 85 in favor C. G. Braxmer for badges	78 20
Paid warrant No. 86 in favor J. H. Decker, salary	500 00
Balance on hand	$585 60
	$2,102 15

Mr. Milne moved that the report be received.

Mr. Gardner—Mr. President I have a resolution to offer. It is as follows:

Whereas, Water Works officials are, in a sense public servants, their duty as such is due to their own municipalities alone. Their knowledge and experience is due and at the service of the communities they serve. For the purpose of increasing their knowledge and efficiency they associate themselves for mutual benefit. A large majority of the Water Works of the United States is not represented either in the American or the New England Association, and give no help financially or intellectually to the objects or purposes of these Associations, but are, nevertheless, directly and indirectly their beneficiaries. Therefore, be it

Resolved, That in view of the constant solicitation of information from members of this Association from all parts of the country, the imparting of which is without fee or reward, and for the most part without a return of a line of thanks, and the solicitation of which is virtually a liberty taken with the person addressed, this Association recognizes as its ethics the right of solicitation of information and advice between its members and prompt full response to same when the information or advice sought is a personal matter or for personal benefit. And

this Association recommends that its members exercise their most careful discretion as to imparting gratuitous advice, counsel or information to those outside its ranks.

I move the adoption of the resolution. I think there is ample room for discussion and I would like to have it discussed.

Mr. Milne called for the question, which was put and carried.

Mr. Gardner.—I would ask the President to direct that the Secretary note that the resolution is unanimously carried and that it be so recorded in our printed proceedings.

The President. –Is there any other special business before the Convention? If not we will proceed to the reading of the papers. The first paper on our programme is the Brooklyn Water Works, by Mr. Samuel McElroy.

Mr. McElroy read his paper, as follows:

THE BROOKLYN WATER SUPPLY.

By Samuel McElroy, C. E.

In requesting me to prepare for this meeting of the Association, a paper on the Brooklyn Water Supply, our President was, of course, well aware that the important statistics of the Works were published periodically and readily within reach.

I take it for granted therefore, that inasmuch as this work, not only from the special date of its first construction, and the magnitude of its scale of supply as a pumping power, but, more particularly from the fact that its design, in various ways, has controlled that of subsequent works, anything which can be said about the statistics of supply is subordinate in importance to a summary of the principles of construction adopted, as to contract, sources in quantity and quality, aqueducts, pumps, reservoirs, distribution and extensions anticipated.

I propose to present, in a rapid way, for a paper of limited length, these questions of construction principles.

PRELIMINARY STEPS.

It is difficult to understand in the powerful, systematic progress of public works at the present day, the embarrassments which surrounded all public outlays thirty or forty years ago.

The capacity of the country for certain and rapid development was not then demonstrated as now: the capacity and willingness of the coming generation to meet the obligations contemplated was doubted: there was great reluctance to give up the methods of a past generation for what

were to some extent deemed luxuries rather than necessities; the fear of greatly increased taxation made the projects of men who lived ahead of their age, unusually hard to develop, and acted as an incubus on engineering, which required special tact and prudence to overcome and had to be more or less humored.

It is not surprising then, that a city like Brooklyn should have gone through various spasms of water supply, for about twenty-two years, and twice voted down plans submitted to the electors before the contract was made, under which a hypothetical consent of the city to be supplied was executed.

The preliminary plans received the attention of prominent hydraulic engineers. Dewitt Clinton in 1832, Major D. B. Douglass in 1835, Wm. J. McAlpine in 1852, Gen. Ward B. Burnett in 1854; for supply from wells and streams on the north and south sides of Long Island; on scales of supply from 2,750,000 gallons per day in 1835, not less than 5,000,000 in 1852, and 20,000,000 in 1854. The population of the present city area, was in 1840, 42,622; 1850, 130,757; 1860, 266,674; 1890, 806,343.

CONTEMPORARY WORK.

Before 1860, in this country, public city and village water supply was exceptional.

Philadelphia in 1801, began the use of the Schuylkill by steam pumps; Baltimore had a gravity supply from Gunpowder River in 1804; Cleveland pumped from Lake Erie in 1810; Albany used the Maizlandts Kill in 1813; Cincinnati pumped from the Ohio in 1820; Detroit from St. Clair River in 1827; St. Louis from the Mississippi in 1830; Chicago from Lake Michigan in 1840; New York introduced the Croton in 1842; Boston in 1848 the Cochituate; Buffalo pumped from the Niagara, and Jersey City from the Passaic in 1852; Washington used the Potomac in 1853, Savannah pumped from the Cooper in 1854. These were the principal, but not the only supplies in use.

In 1860 New York was using about 50,000,000 gallons per day; Philadelphia, 20,728,985; Boston, 17,238,000; Chicago, 4,703,525; Albany, about 4,000,000; Detroit, 2,383,661; Jersey City, 2,216,500.

The ratio per capita varied from thirty-seven gallons at Philadelphia to nearly 100 at Boston, New York about sixty-three. In 1849 London distributed 44,383,332 gallons (Imp.) to 2,156,417 population, or 29.85 gallons each. Under a standard of fifty gallons minimum the Brooklyn supply provided for a population of 400,000, that of 1860 being 266,661. The scale of supply then rivaled Philadelphia, and both stood next to New York.

CONTRACT PLAN.

The Nassau Water Company, holding special privileges of supply, President, Hon. John Vanderbilt, Chief-Engineer Samuel McElroy, on May 3, 1856, under an arrangement agreed upon by the Common Council and a committee of prominent citizens, was enabled to commence construction by a city subscription of $1,300,000 as preliminary to absorption of the company by making commissioners of its seven directors in 1857. Under this contract with Henry S. Welles & Co., the entire works were built, the first supply being introduced December 16, 1858. Up to this time the general practice of public works was that of sub-

division into larger or smaller sections, to a number of contractors who were paid specific prices for the different classes of work. The advantages, however, in a work like this, of perfecting all the details in advance, and bringing them under one contractor for a fixed sum, were so obvious, that this method was adopted at the outset, and this system has gradually superseded other methods on public works. The magnitude of the supply, the selection and gauging of the streams required; the adequate purchase, control and guarantee of the supply; the location, elevation, size and protection of the supply and storage reservoirs, the use of a trunk aqueduct and of pumping engines and structures of unusual dimensions; the regulation of the relative powers, duties, and responsibilities of the Commissioners, engineers and contractors; for a supply of not less than 20,000,000 gallons per day, under contract price of $4,200,000 required in preparing the plans, specifications, contract, and estimates, an elaborate study of all the local conditions of the best hydraulic constructions, their cost and value, and no small faith of city authorities on one side, and the contractors on the other, in engineering judgment, which the severe test of actual construction fully vindicated.

THEORY OF SUPPLY.

Long Island, in the main, is composed of a porous mass of sand and gravel, with occasional deposits of clay, sloping up from the ocean on the south, and the Sound on the north to a central ridge less than 200 feet high in Brooklyn, extending easterly, with higher elevations throughout the Island. The rain, falling on this surface, is easily absorbed, and passes down to a saturated bed as through an enormous filter, which rises landward from tide level with an hydraulic or frictional slope, generally of eight or ten feet per mile. On the Hempstead Plains, at a distance of ten miles from tide, the saturated bed is about seventy-five feet above mean high tide, and 125 feet below the surface. Along the southern slope, easterly from New York Bay, depressions occur in this formation at frequent intervals near tide level, generally in the form of swamp beds, from which powerful springs issue forming short creeks. These have a slope closely corresponding to the saturated bed from which they spring, practically an enormous subterranean storage reservoir. Their flow is about forty per cent. of the annual rain supply and discharge of this bed, which amounts to about 1,200,000 gallons per square mile per day, under a mean rain fall of forty-two inches. These streams were generally ponded for small mill sites, at nine to sixteen feet above tide; they are remarkably fine in quality from their great sand filter; and uniform in flow, from their great reservoir storage, which the weather cannot much affect. They are not much subject to freshets, forty-eight hours being an extreme period of increased storm flow, nor much diminished by the effect of summer heat in September and October. During several years, (1872, 73 and 76) the July flow of six streams used, was at least 36,000,000 gallons per day. The daily discharge of the district they drained on 12.39 miles of aqueduct, with 88.64 square miles area, is not less than 106,000,000 gallons per day, nearly twice the present consumption of Brooklyn.

SOURCES—QUALITY.

The peculiar formation of this island, and the location of the intercepting aqueduct near the tide line, draining practically the enormous

filter bed above it, obviates for Brooklyn, to a large extent, a contingency of contamination, which must become a very serious problem to most cities, as time goes on.

Of course, over the area on which the rain supply now falls, there will be a continued increase of population, with its inevitable need of sewerage, factory discharge, land cultivation, and all the processes which affect water constituents. But as nature by soil filtration has provided the simpliest and most efficient chemical and zoological correctives of organic and other contaminations, and over this saturated bed the depth is great as a rule, ultimate injury is greatly postponed and will be much confined to local cases.

All water exposed to organic solutions is, however, more or less subject to the fermentation process which nature has provided for its depuration. This action was too clearly demonstrated before this date in Boston and other cities, not to require special methods of correction. The contract provided that the entire supply beyond "Jamaica," the first pond, should be delivered into it as a subsiding and corrective reservoir, and the purer surface water decanted into the aqueduct. At Ridgewood, the reservoir, on the Philadelphia plan of successive decantation which only has made the use of the Schuylkill possible, was divided into three apartments, with connecting gate piers to secure a surface delivery from each, in succession, to the last. In construction, both these precautions were abandoned; as a result the supply is, at times, far below the standard of its sources as surface or top layer supply through proper subsidence, is the purest as well as the lightest part of a reservoir; the neglect of its delivery in many cities, notably in New York for many years, is highly objectionable.

AQUEDUCTS.

From the Pumpwell to Jamaica Creek, 4.85 miles, the aqueduct, a very substantial wagon section, stone and brick structure, on concrete, was made 8⅝ feet high by ten feet wide, inside, section 73-46 square feet, the original Croton being 53.34; thence to Hempstead reservoir, it reduces gradually to 6 5-6 by 8 1-6 feet; grade about 6½ inches per mile. Under the original plan purchases were made of Smith's pond, on Hempstead Creek, and two large ponds on the extension line east. The floor grade of the aqueduct at Hempstead Creek being 8.28 feet above tide, it was proposed for the future extension, to make Smith's pond (3.5 feet above tide) a receiving reservoir and pump for a short lift of about ten feet, the eastern supply. For the 10.33 miles to Massapequa Pond, at six inches per mile, the grade at the east end would be about 5.5 feet, controlling an aqueduct depth of about 5.75 feet.

The extension has recently been built, but this economical continuation of the original system has been abandoned, by building an artificial reservoir east of Smith's pond, with a flow line forty-seven feet above tide, capacity about 403,000,000 gallons. From this a forty-eight inch iron main is laid to the house of engine, No. 5, at Ridgewood, about 70,450 feet, parallel with the aqueduct. The Milburn reservoir is supplied by a forty-eight inch pump-main, about 5,150 feet long, from the Milburn engine house, where the extension aqueduct ends, 2.9 miles east of Smith's Pond. The aqueduct thence to Massapequa Pond is of brick masonry, wagon-section, varying from 6.917 to 5.917 feet in height, and

9.334 to 7.334 in width, inside, with 52,134 to 35,223 square feet section. As there is now a larger pumping plant at Smith's Pond, lifting its supply to the aqueduct, it is difficult to understand why the original plan of extension was not followed.

AQUEDUCT FLOW.

The fact that our large aqueducts show much higher velocity, with a given section and slope than is due to the old Chezy formula, [v (feet per sec.)=92.66 sq. root (mean hydraulic radius) + I (slope ratio)] early noticed on the Croton and Cochituate aqueducts, and applied to the Washington aqueduct case in 1861, is due to compound action of the wave, and makes the wagon shape preferable to the circular, for this and other reasons.*

Some experiments of 1888, on the Brooklyn, made the constant 135.65 or about 46.27 per cent. above the Chezy for a depth of five feet; as however, a pumping capacity for the full aqueduct flow controls the outlet, the capacity of the main aqueduct much exceeds its normal capacity of at least 100 millions per day, or about twice the present supply. The Croton aqueduct with much smaller section, just running full, carries 115,000,000 with thirteen inches fall per mile.

PUMPING PLANT.

The plant built 1858–60, was two Cornish double-acting engines, ten feet stroke, eighty and ninety inches bore, pumps thirty-six inch bore, same stroke; capacity 15,000,000 gallons per day each, with two large auxillary pumps. The boilers were "double return drop flue," eight feet diameter by thirty feet long, three to each engine, evaporating about ten pounds water per pound coal. These were placed in a large ornamental engine and boiler house of brick, with sand-stone trimmings on a granite pump well, built for four similar engines and fitted with the best appliances for effective and economical work, and connected with the reservoir by two thirty-six inch mains of extra thickness and construction, with large check valves on the line, and air-chambers in the engine house. At that time the single-acting Cornish engine was the most economical high power engine in use. The old Ford engine, East London Water Works, with boiler evaporating 8.52 pounds per pound coal, steam only thirty-seven pounds, (22.3 gauge) cut off low, 31.3 per cent., piston duty 1,215,423 foot pounds, equivalent pump duty 917,472 foot pounds per pound coal, or about 1.87 pounds coal per H. P. per hour. With 125 pounds steam (gauge), 1-18th cut-off and better boilers, our high duty compound engines now do not exceed about 1,200,000 foot pounds, and there are few engines down to 1.87 pounds coal per H. P.; 1.45 the best record. The special principles of the engines built were: The economy of large engines in preference to small ones, in space, coal, attendance, operation and repairs; their need under rapid increase of water use; the direct action of the steam piston on the pumps by counter-weighted beam vibration; the delivery of the pump buckets through each other, one being under each end of the beam to maintain a contant water flow in the same direction and full harmony between the pump wave and steam pressure; the use of large, double beat valves and passages; the use of a large air chamber, in preference to a stand pipe to

*Jour. Eng. Societies, Nov. '87, "Hydraulic Motion."

cushion pump action. For the engines and boilers the best Cornish or American system of valve construction, steam jacket, clothing, and other economical devices were used; and, for the first time, with us, the duty performance of 600,000 foot pounds, was made a direct condition of engine acceptance. These engines passed their duty test before they were properly counter-weighted; with about nine pounds cylinder steam and 4-10 cut-off, as the result of their remarkable economy in motion, with a speed of 189 to 200 feet per minute, lifting about forty tons water, about 170 feet, without perceptible jar on the thirty-six and fifty-four inch pump valves with only 6.7 per cent. friction, of which 2.94 was in the pumps, it was evident that properly loaded to take higher steam and expansion twice the duty was available. Their repair account has been low, and No. 2, after thirty years constant service, is making a little over ten double strokes per minute, doing more work than any other engine at the station. The record of the boilers has also been remarkable. In principle there can be no question of the superiority of firing within the boiler shell, in evaporation, air supply, reduced expansion and contraction, tightness and durability. The upper flues are adequate combustion chambers; the greatest quantity of steam is made from the thinnest layer of water; about three-fourths the furnace heat was utilized at the first return, and with the gases at the lowest return going into the chimney at less than 300° there was a clear harmony between full heat use and complete circulation from feed supply to upper sheet supply. The boilers of No. 2 were in use over twenty five years.

As economy required within the city limits, two supply elevations were adopted, one the 170 feet flow line of Ridgewood, and a small one for the 197 feet flow line of the Mount Prospect reservoir. For this the auxilliary engine house and engine were built, capacity assumed 3,750,000 gallons per day; actual delivery rate in 1890, 5,346,640.

ADDITIONS.

As appears in the pumping plant table, the department, with a daily delivery in 1890 of 55,103,370 gallons, has a pump capacity at Ridgewood of about 87,000,000; its high service capacity is about 10,000,000; the auxillary supply to the aqueduct is now a total capacity of about 111,000,000, with the extension pumps at Milburn covering 34,000,000, a grand total of 208,000,000 for a daily delivery less than one-third.

Of this former about 77,000,000 are allotted to low-lift pumps from driven or other wells, into the aqueduct, their equivalent supply being about one-half of the city use in 1890. These are distributed at eight stations, each requiring all the appliance of a central station and expensive attendance. To pump about one-half the supply less than 10 feet costs about one-eighth the fuel which pumps the whole more than sixteen times the lift, at Ridgewood, in a case where much more water would run down hill into the aqueduct, as at Hampstead Storage Reservoir, if it was drawn from the saturated bed.

With all the duty progress of pumping engines around us, claiming from 900,000 to 1,250,000 ft. lbs., it is singular that up to 1890, the Department quietly submits, from its enormous surplus plant, to an annual fuel loss of one-third to one-half the large quantity used. It is to be hoped the No. 5 Worthingtons and Milburn Davidsons will change this record. As a study of unbiased selection, the various styles of engines built is also a curiosity, as shown in the following table:

PUMPING PLANT—BROOKLYN WATER WORKS—1890.

STATION.	Engine	Design.	Supply Source.	Running Time. Days	Gals. Per Day.	Capacity Assumed.	Coal used. lbs.	Attendance Cost.*
Mt. Prospect....	No. 1	Crank.	City Main.	198.76	5,346,640	5,000,000	902,390	
do.	2	Crank.	do.	112.62	3,898,290	5,000,000	592,100	$3,500
						10,000,000	1,494,490	
							Tons 667	
Ridgewood.. ..	1	Crank	Aqueduct.	288.19	14,047,560	15,000,000	10,590,100	
do.	2	Cornish.	do.	347.72	14,047,560	15,000,000	15,701,100	
do.	3	Crank.	do.	347.76	15,347,000	15,000,000	12,690,100	
do.	4	Davidson.	do.	345.71	16,036,470	15,090,000	17,319,700	
							56,301,000	
							Tons.	
do.			Driv. Wells.	12.84	6,856,300	7'000,000	25,090	$90,970
						67,000,000		
Spring Creek...	1	Worthington	do.	286.08	2,849,000	3,500,000	813,240	
do.	2	Worthington	do.	286 83	2,837,700	3,500,000	817,780	
Jameco.	1		do.	188.60	6,987,080	7,000,000	749,033	
do.	2		do.					
do.	3		do.	158.30	3,559,400	4,000,100	539,755	
Baisley's	1	Knowles.	do.	195.10	1,752,000	3,000 000	408,250	
do.	2	Knowles.	do.	169 34	2,104,100	3,000,000	422,900	
Springfield	1		50 ft. well.	200.54	4,153,810	5,000,000	606,455	
do.	2		do.			5,000,000		
Forest Stream..	1	Wright.	do.	138.34	5,124,000	5,000,000	408,974	
do.	2	Wright.	do.	113.35	5,133,600	5,000,000	341,574	
Clear Street. ..	1	Wright.	do.	77.35	5,491,300	5,500,000	220,445	
do.	2	Wright.	do.	121.38	5,366,700	5,500,000	322,600	
Walts'.	1	Worthington	Pond.	170.63	2,995,000	3,000,000	528,310	
do.	2		do.			2,000,000		
Smith's..... ...	1	Worthen.	do.	161.22	4,324,500	7,000,000	335,500	
do.	2	Davidson.	do.	165.54	5,490,000	5,000,000	474,050	
do.	3	Davidson.	do.			5,000,000		
				47.6 % of year.	58,168,190	77,006,000	6,988,566 Tons.	$34,900
							3,130	$59,370

Annual Rate 27,688,058.

*Estimated from 1877.

EXTENSION.

Ridgewood. ...	No. 1	Worthington	48 in Main.	10,000,000
do.	2	Worthington	do.	10,000,000
				20,000,000
Milburn.	1	Davidson.	Aqueduct.	10,000,000
do.	2		do.	10,000,000
do.	3		do.	10,000,000
do.	4		do.	4,000,000
				34,000,000

RESERVOIRS.

Each supply stream, with its original mill pond, was formed as a supply reservoir to the aqueduct. These were:

Name.	Aqueduct Distance Miles.	Area Acres.	Level above Tide.
Jamaica	4 848	40.00	9.23
Brookfield	7,360	8.75	17.04
Clear Stream	8,395	1.07	13.14
Valley Stream	8,249	17.78	14.44
Rockville	11,988	8.00	13.64
Hempstead	12,390	23.52	12.24
		99.12	

The city reserve was "Ridgewood," with 25.58 acres surface, 20 ft. depth, flow line 170.24 ft. above mean high tide, capacity 161,220,000 gallons; and Mount Prospect, 11.08 acres surface, 20 ft. depth, flow line 197 ft., capacity 20,000,000 gallons. This reserve was about 18 days supply for 1860.

The ancient theory of proper water-tight bank construction was adopted in the contract, with substantial brick and concrete masonry slopes and floors. During construction the plan, at Ridgewood, was changed, for a dry wall, and the first experience, with about seven feet water in 1858, led to a careful cement grouting of the slopes. Mount Prospect reservoir was built with the contract facing of puddling, concrete and brick masonry, and has proved a very substantial structure.

It is much to be regretted that mistaken theories and ideas of economy have, in many cases, since that time, led to the construction of defective banks and slope walls, for Brooklyn, and other cities, in resistance to wave wash, ice, frost and other contingencies.

About 1875, the Hempstead Storage Reservoir, an enormous excavation in sand, was completed, at a cost of about $1,500,000. Except near its upper end its action is to repress the saturated bed of its district, to reduce the normal flow of its valley, and cause large lateral waste though it was pledged to furnish 10,000,000 per day for 100 days in the hot season, in addition to the ordinary valley flow.

An enlargement of Ridgewood Reservoir has recently been completed, increasing the storage to about 320,000,000.

At Milburn, on the new aqueduct extension, a terminal reservoir of 403,000,000 is being completed.

On the same line the supply reservoirs, east of Smith's, on Hempstead Creek, are:

	Area Acres.	Capacity Galls.
Milburn	17.2	19,500,000
East Meadow	11.8	23,500,000
New Bridge	9.3	16,500,000
Ridgewood	16.7	23,500,000
Massapequa	13.8	31,000,000

DISTRIBUTION.

After a careful study of the Philadelphia, New York and Boston pipe systems, to secure adequate circulation on a terraced city with great local advantages, the relative schedule adopted was:

Thirty-six inch mains into the city, 5 miles; 30 inch, 5; 20 inch, 4; 12 inch, 12; 8 inch, 30; 6 inch, 64; no smaller mains being allowed; total, 120 miles. The hydrant branches were four inch; number of hydrants, 800; stop cocks, 690 in all.

THE SCHEDULE OF 1890 WAS,

Mains.	48"	36"	30"	20"	16"	12"	8"	6"	4"	
	M									
Length.	6.343	8.554	5.855	18.792	2.061	39.924	74.826	278.705	0.733	
Stop Cocks.	4	12	15	116		261	497	2235	14	
Total Distribution								432.875		Miles.
Stop Locks							3,154			
Hydrants							4,251			
Taps							89,493			

Up to this time the pipe lengths were adapted to 9 feet from joints. The advantage of increasing this to 12 feet was so obvious, that this standard was adopted. It met with great opposition from the foundries, and compelled a preliminary contract with a Scotch foundry; but that ended the discussion, and this has been the practice since. It involved the necessity for the larger sizes, of casting a number of pipes, vertically, in a circle around the pit to secure uniform cooling.

The common practice of casting sizes below 20 inches led to many objectionable effects on their form, strength, quality and durability. The change to vertical casting was pressed, and is now claimed to be universal in foundry practice.

Pipe tuberculation was well defined in the Boston, New York, and other experience, and the use of Dr. Smith's Glasgow Coating was adopted for the larger mains. It acted as a detergent for several years, in many cases, and as a hot bath of coal tar and varnish, is now universally used.

A careful study of this chemical action which destroys a pipe, often within twenty years, and sectionally reduces its flow long before, shows that an important remedy is to improve the quality of the iron used. Cheap grades containing an important per centage of carbon, and mains joined with different qualities, exposed as they are to different temperatures and qualities of water, galvanic action, acids, gas leakage, external moisture, excavation and other strains, are not adapted to long service. In some cases, near the New York docks, the life of a pipe is very short. Corrosion in ten to twenty years has occurred in various cases, and sixteen to twenty-five years is the probable limit of service; while instances of great duration sometimes occur, due to superior pipe quality, or reduced exposure. In connection with carefully improved quality of iron, if the mains are lined and coated with a substantial layer of hydraulic Cement Concrete, their durability would be greatly improved; and the time is coming when both these improvements, or their equivalents, must be adopted.

The common house service with us uses lead pipe, wholly or in part. There can be no question that the conditions of lead use, are often questionable. The great prevalence of neuralgic and kindred diseases may, or may not be caused by lead cumulations, but it is certain that lead service makes this convenient. Something of the care which is now growing excessive as to sewer contamination of water supply, in large rivers, ought to be consistent in equal study of house contamination, by lead pipe, which sometimes are renewed every six or eight years.

As to the hydrants which are now, or should be adopted in size of branches and nozzles to steam fire engines, there are two important improvements to make; to get rid of the friction of the clumsy central valve rod, and thus promote flow; and to connect them with the sewers to prevent freezing.

FINANCIAL EXPERIENCE.

The income from water supply is so large and easily collected, that with ordinary care in administration it ought to pay well on investments.

The Brooklyn statistics, however, do not show income gain from water supply. While the receipts for thirty years, including 1890 have been large, $26,656,000, the cost of operation and maintenance is $9,543,000; but the continual issue and life of the bonded debt has involved the extravagant outlay for interest of $16,698,000, and the addition of about $9,543,000 in extensions to the original outlay of $5,440,000 brings the total present expenditure up to about $43,301,000, or a deficiency of about $16,655,000.

FUTURE SUPPLY.

Taking its water from the vast saturated bed of the Island, near tide level, after its percolation through deep beds of sand, and reaching out over a large district of such supply, Brooklyn is most fortunately situated for future population.

But, in such cases as that of the Croton Valley for New York, the problem of future supply is a very serious one, where a single generation is to make large increases in population. Two contingencies are quite sure; the gradual increase of demand for the supply in the valley proper, which must gradually effect the city draught; and the gradual contamination of the supply from inevitable and necessary local conditions. When the 325 square miles of this valley deal with the dozen square miles actually owned by the great city, it is a matter of simple common sense to know, that no legislature and no courts can ever permit the city to prevent the owners of the valley from the natural and necessary first use of the water which falls on their own territory.

Obviously then, the first effect will be a gradual and sensible growth of economy in city use of water. It is absurd to justify the use in New York, dirty as she is, of four times the rate per capita of clean London. By meters then, and by other methods of restriction, the common sense use of the Croton will be forced, as it will be in in all large centers. With this will come another common sense improvement in the simple, economical, and effectual purification of the aqueduct supply before its entrance into the city reservoirs, from its organic and mechanical impurities. That this can be done on a perfectly adequate scale, we know now; that it is neglected inexcusably, we also know, but as the consumption is reduced, chemical and mechanical purification can be increased, and in this way a very important gain can be made for a centre which is soon to count at least five million citizens. The lesson of this generation to the members of this association is the actual ownership and control of the catchment basin of supply, as far as it can be carried; the present appropriation of quantities needed many years hence, the gradual reduction of the waste by consumers, and the absolute purification of the aqueduct and main deliveries.

THE PRESIDENT.—You have heard the paper. Are there any remarks? We will probably see part of these works that have been described, when we visit Brooklyn on Friday.

MR. JONES.—I want to ask a question. What amount did I understand Mr. McElroy to say was the discrepancy between the receipts and disbursements?

MR. MCELROY.—About $16,000,000.

MR. JONES.—In how many years?

MR. MCELROY.—In about thirty years.

MR. JONES.—I have an impression that this is the condition o affairs in almost all cities in which the water works are owned by the city. If any representatives here know of any public water supplies that are making money I would like to hear from them.

THE PRESIDENT.—I believe that the reports of Hartford show a profit. I do not know of any other city. In Hartford it is probably owing to Mr. Ayers efficient management. Are there any other remarks?

MR. MILNE.—Mr. Chairman, the local committee have arranged for an excursion to the scene of Mr. McElroy's early labors. There is no man in the country today so familiar with water works construction as our friend who has given us this paper. If we have time we will there see the initiative construction of the Brooklyn City Water Works, together with all its supplementary features from that time down to date. I am sure it will be very interesting to the members of this Association to have the pleasure of seeing full details in regard to the system; not only the features that Mr. McElroy has spoken of, but also the details of pumping practice and pump construction as well as the arrangement of the boiler power features.

THE PRESIDENT.—If there are no further remarks on this paper we will proceed to the next order of business. The next paper is one by Mr. L. E. Gray. It is entitled "Who Should Do the Plumbing Work?" The paper is here and the Secretary is supposed to read it.

but the Secretary is not here. We will postpone Mr. Gray's paper and proceed to the next order of business, which will be "The New Water Supply for Atlanta, Ga." by W. G. Richards.

Mr. Richards read his paper as follows:

THE NEW WATER SUPPLY FOR ATLANTA, GA.

BY WM. G. RICHARDS, SUPT.

During the Cotton Exposition which was held in Atlanta in 1881, Mr. Emil Geyelyin, of Philadelphia, the well-known hydraulic engineer, called upon me and visited our pumping station; he noted the evident rapid growth of the city, and remarked that we would soon outgrow our then present water supply, and asked me if I had given the subject of a more abundant supply any thought, and, if so, had I any plan. I told him that naturally, in my position as superintendent, my attention had been drawn to the increase in the consumption, and that I thought the future supply would be taken from the Chattahoochee river, at a point at which the stream could receive no contamination from drainage from the city, and that the particular spot would be just above the mouth of Peachtree Creek. This location is very favorable in many respects as there are the valleys of two large creeks which intervene between the city and the river. The city is laid out in a circle radiating from a center at the Union passenger depot, and this location on the Chattahoochee is protected absolutely from pollution until the city shall have grown above a diameter of twelve miles, and even then at the expense of extending the pipe up the river, the intake may be protected indefinitely.

I may say that my general plan outlined to Mr. Geyelyin in 1881 is substantially the one adopted after going over the territory in almost every direction and to almost every available source of supply. The city consulted Mr. Rudolph Herring, and he and Mr. Clayton, our able city engineer, finally adopted the plan upon which the works are now being built.

The city datum is 1050 feet above the sea level, the river, at the point alluded to, being 760.

The difference is placed at 300 feet, although there are some localities within the city that are forty feet above this. The head to be overcome, to afford a satisfactory domestic pressure, would be 400 feet; and, to furnish a pressure for fire purposes, including friction, makes a head above the river of 500 feet. This, while not being outside the line of possible good results from one set of pumps, was not deemed as safe as to divide the lift and erect two stations, one at the river and another at a suitable elevation that would about equally divide the head. This plan was adopted by the Board of Water Commissioners, and, by them, and the General Council, the City Engineer and Superintendent of Water Works were required to mature plans and construct the works. The plant, when complete, will consist of two pumping engines of 10,000,000 gallons daily capacity each at the river. These engines will discharge into a storage reservoir whose surface will be 985 or 225 feet above the river. At the level 935, or forty feet below the surface of the water in

the reservoir, there will be located a filter plant which, at present, will have capacity for filtering from 6,000,000 to 8,000,000 gallons in twenty-four hours; the filters will discharge into a clear water basin holding 1,000,000 gallons, thence the water is taken, by a second set of pumping engines, and discharged through a thirty-inch main pipe directly into the city distribution.

The pressure to be maintained throughout the city, will, according to altitude, be from forty to sixty pounds as the regular or "domestic pressure," and, in the event of fires, will be from eighty to 100 pounds. Just here it is well that a word or two be said to explain why preference is given to the direct pressure or Holly System. Atlanta is situated at the southern extremity of the Blue Ridge, and is on the highest spot of ground to be found within a radius of fifty miles, and, should the expensive luxury of an elevated reservoir have been contemplated, it would have been impossible to have found a location that would afford a satisfactory pressure for domestic uses, not to mention fire service.

Our citizens, the firemen, and the insurance companies have become used to an immediate fire pressure direct from the hydrants, and would now be very reluctant to accept any system that would require more than a minute to obtain a satisfactory fire pressure. In my opinion there is no substantial argument that can be brought against the direct pressure system if its application be correct. It is acknowledged that it will answer in cities of small area, which the writer is of the opinion is an acknowledement that it will answer for cities covering the greatest area, and only requires that the main conduit branch to different pumping stations, at which district pumping engines be located, and by this means a pressure satisfactory for any and all purposes, or emergencies, would be obtainable, and the use of steam fire engines become of little need.

New York, Chicago, or London might as well have a good fire protection as the little city of Atlanta. Some of you will say that I have left my tangent and gone off what was to have been the subject of this paper; but, as the main object of this society is to impart our ideas to our fellows, such is the purpose of this digression. I have given the general plan, and will now begin at the river, or Station No. 1, and give some of the items of construction.

The Chattahoocheet, at the point of intake, rises from the low water mark to a height of twenty-six feet. A dyke or levee is being built to enclose about two acres, inside of which the engine house is being built. The intake is a forty-eight inch iron pipe 600 feet long, the outer end of which will be about one foot below extreme low water, and, having a fall of one foot in its entire length, terminates in an elliptical shape suction well whose diameters are 30 and 60 feet. There are 30-inch suction pipes from this well to the pumps. The pumps will have a maximum suction lift of sixteen feet, varying according to the stage of the river. There will be a valve on the intake pipe to control the height of water in the suction well, there will also be a by-pass connection on the river side of the valve, and connecting with the rising main to the reservoir to be used for the purpose of flushing and cleansing the intake. There is is also provided a drainage well within the dyke enclosure that may be pumped out in the event of any continuous high water. The machinery at this station consists of two 10,000,000 gallon, horizontal, high duty

Gaskill engines; a thirty-inch iron pipe will convey the water from these pumps to a storage reservoir at No. 2, the distance will be 17,000 feet, and an elevation above the pumps of 210 feet. The reservoir will have a capacity of about 180 million gallons, and it is expected that this storage will tide over any unusual high water in the river, and afford an opportunity of stopping the pumps during seasons of heavy rainfall and consequent turbidity, and, also to afford a supply should anything happen to pumps or pipe line. It is contemplated that a parallel main will be run between the two stations in the future. The receiving reservoir is, happily, located in a deep ravine and is formed by the construction of two dams, which cross at sufficient distance to embrace about twenty acres, and affording—as before mentioned—a storage of about 180,000,000 gallons. The natural levels of the sites selected all seem favorable for a construction on the plan upon which the work is being carried out. The streams of this section carry a large amount of the abounding red clay soil, the coloring matter of which is held in suspension for a long period and the rivers rarely become clear until the effects of the rains have passed off, and the water from the springs, from which they derive their source, predominates. It may be possible to remove this coloring matter by settling basins; but this would be an expensive arrangement, and, the gravity filter having proven a splendid success in the operation of the old works, it was decided to adopt it in the construction of the new plant. The filters at the old station are working very satisfactorily, with a gravity head of twenty feet, and it is expected that these, which are to have a gravity head of forty feet, will work to even a greater degree of satisfaction. There will be a thirty-six inch pipe extending from the storage reservoir to the filters, and also from filters into the clear water basin. The clear water basin will be built of brick and will be circular, 100 feet diameter, twenty feet deep, holding 1,000,000 gallons. When full the water will be on a level with the floor line of the engine room. The situation is such that there is drainage with ample fall from filter and engines at this station. The machinery at this station consists of one High duty 10,000,000 gallon Gaskill engine, and one Holly quadruplex of 4,000,000 gallons daily capacity, the latter being one of those now in service at the old station, and which the Warer Commissioners desire moved to use as a relief for the Gaskill, though it is hoped by the writer, and also by Mr. Clayton, the engineer, that, as the work progresses, they may be persuaded to secure another Gaskill of same dimensions as the first, it being of doubtful policy, at most, to move a pump to this station which will hardly supply the wants during the midnight hours. Extending from Station No. 2, into the city distribution is a thirty-inch pipe for a distance of about one and a half miles; this will be distributed into one twenty, and two sixteen inch, the sixteen going east and west, and the twenty-inch passing directly south through the center of the city.

This twenty-inch pipe was connected with the old system at the start, and is being laid from the center out toward the pumping station, and is also being connected at all convenient interjection on the line with the city distribution. This work is being done by the water department and is being thoroughly tested as the work progresses. The valves on this line are about 1,000 feet apart, and, as each section is laid, and before the ditch is filled, an air-cock is inserted at the highest point in the section, and another at a low point; after all the air has passed off, a

boiler test pump is attached at the low point and a pressure of 250 pounds is pumped up, and, if there are no leaks, the ditch is then filled. I am pleased to say that up to the present time I have not found a single faulty pipe, or special, in the ditch, and none outside excepting a few lengths that have been cracked in transit, or unloading. I think this plan of testing pipe, when laid in connection with an old system, a good one; as it removes all uneasiness of leaks in the future. A hammer test and close overlooking before laying, is all the tests these pipes receive excepting the customary foundry test. The pipes are being furnished by the Howard Harrison Iron Works at Bessimer, Alabama. There is two inches depth of lead put in the joints. The station at the river is a mile and a half from the main line of the Western and Atlantic railroad, and it was necessary, therefore, to build a branch road. The station, No. 2, or Reservoir station, is immediately on a side line of the Richmond and Danville. The city has appropriated $750,000 for the construction of the works, including land and every other item. The contracts, covering every part of the work, have been let, and, so far as can be seen the cost will be within the sum of the appropriation. The work seems to be progressing very evenly. The engineering, in all its features, is under the direction of Mr. Robert M. Clayton, our City Engineer, and a member of this Association. The machinery and pipe laying being my part of the work. I might lengthen out this paper with many minor details, but consider it a useless consumption of your valuable time.

The President—You have heard Mr. Richards' paper. Are there any remarks?

Mr. Fuller.—Mr. Richards spoke of a storage reservoir and also about a direct pump. I suppose I did not exactly understand the arrangement. Is a storage reservoir used in connection with a direct pump, or is there something different?

Mr. Richards.—We have two pumping stations, one of them being at the river. The water is pumped out of the river into the storage reservoir and then it is taken from the reservoir and pumped direct into the city main. That just about divides the lift.

The President. These descriptive papers do not seem to admit of much discussion. At the same time they are very interesting and a great deal may be learned from them. If there are no further remarks we will now take up the paper by Mr. L. E. Gray, "Who Should do the Plumbing work?"

The Secretary then read the paper, as follows:

WHO OUGHT TO DO THE PLUMBING.

BY L. E. GRAY.

Mr. President and Members of the American Water Works Association:

GENTLEMEN:—I will give you my idea of who is to do, or who ought to do the plumbing. My idea is that the water-works company, be they private or public, should do the plumbing attached to or used in connection with a water-works, and that gas companies should do all work attached to their gas mains.

Now why? First, for economy; second, so as to have things done proper; third, to have the right kind of material used.

For economy: Well, how can that be, you may ask? To answer that I will take Albany as an illustration. The water consumers are very wasteful. To stop this waste will be economy. Now you will be interested to know how to stop it. Let the water-works company make strict laws. First, let no one have water, who will not let the company do all of the plumbing on their property. Second, let no one have water who will not let the company inspect the plumbing whenever they see fit to do so. Third, let no one have water who will not let the company's plumber do the repairing, the repairing to be at the expense of the property owner or occupant. Then let the company have a man or woman as inspector who can be abused over and over again. Let him go from house to house and find where there are any leaks. Let him make a memorandum in a book for such work; of all that he thinks will be needed to repair such leaks. Then when he returns to the office let him give the book to the plumber. Let the plumber take such stock as is necessary and all of his tools (on a conveyance of which I may write hereafter, or if any one wishes to know I will answer their letter any time), and go and repair from house to house, and keep strict time of all work done.

Here, then, are two economies: First in words commanding the repairs to be made, when you say, "I will send the plumber to make the repairs."

Second, economy to the property or renter, because the work can be done in half the time it could be done otherwise. You also economize on water by having the leaks stopped, and you know they are stopped. You feel certain that when you send out your plumber that he will do his work so that he won't have to go back. If he did you would soon discharge him, which you ought to do. You would be the means of having better material used, and consequently receive better work, as you would only put in the best material you could get, which would be economy to the property, as they would not have to buy so often. To explain a little better, come and take an imaginary trip with me.

Suppose I had full control of a works so as to get what tools and material I wanted. I will now take my outfit and plumber and go to a place needing repairs. The first thing I would do would be to locate the water pipe, and mark it down (on a blank made for it) the exact location and amount of all the pipe, also the ground plan of the house, and if two or more stories, the ground plan of each floor; mark down all basins and water closets, and sinks, bath tubs and sewer pipe; also all traps and air vents, and, as near as possible, the kind of material used, and, when possible, the maker's name. After that I would make what repairs were

necessary and go to the next house, and so on until noon or night. Then at night return the blank to the office so that they can copy off your report into a book, one page to a lot, and the page opposite for explanations of the plan drawn.

I would then keep a ledger account of all repairs done and the cost of same. You could always tell all about the works and all of its tributaries, the kind of material used, etc. You would always know then how many places where water was used and all the connections. Under the present system you don't always know.

At first thought the plumbers might object to this plan, but it will be better for the plumber, as it will be the means of doing away with cheap and half-way plumbing. It would finally occur that none but first-class workmen could get work, and it would encourage plumbers to be men and fine workmen. But as long as the present system of tin shops and hardware houses doing the plumbing, and they are always bidding down on each other, you must expect and will get poor material and poor work. When any one wants to build a new house or repair an old one, let them give you a plan of the house, and if they have not made the proper allowances for plumbing suggest such improvements as would help out. In building new let the architect make all plans, including plumbing, but don't let out the plumbing by contract. Let the water company do it at as small cost as possible, and you will get good work.

If the architect doesn't make the proper allowances for plumbing, tell the owner and suggest such improvements as are proper. There are lots of architects who don't show the first principles of plumbing in their plans and specifications; in fact, if their plans were followed there would always be trouble. Here in Oregon it is almost impossible to get good brass goods, especially corporation stops, service cocks, stop and waste cocks, hose bibs, etc. It is caused by the cheaper houses trying to undersell each other.

I long for the day when we can get good plumbing goods. I may write some time about plumbing material. I have tried to make myself understood, but if I have not, and any one is interesed enough to write to me and ask what they don't understand, I will try and explain.

THE PRESIDENT.—It is not easy to read a paper written by somebody else without any previous knowledge of its contents, no matter how well or poorly it may be written. I think our Secretary has done remarkably well under the circumstances.

MR. GARDNER.—I think the Secretary has done remarkably well and needs no apology. He always does everything well. I move the Association thank the Secretary for the able manner in which he read the paper.

Carried.

THE PRESIDENT.—While the Secretary is taking breath and as he has to read the next paper on account of the absence of the member who has contributed it,

whose absence is much to be deplored, I will announce the Committee on Revision of Constitution. It will consist of Mr. J. H. Decker, Mr. Peter Milne and Mr. William Ryle.

MR. DECKER.—Mr. President, I must ask you to excuse me from serving on that committee and I may as well state my reason. The constitution as it is now in force was originally drafted by me, It came before the Association and they literally cut it into pieces. For that reason I do not want to have to re-revise work that I originally did and which was cut to pieces by the Association by any means, I respectfully suggest that the President be made chairman of the committee in my stead.

THE PRESIDENT.—I selected this committee of gentlemen who live within fifty miles of New York so that they could easily come together to confer on the subject. It seems to me a proper committee to be appointed.

MR. ESPY.—I move the President be appointed chairman of the committee.

MR. GARDNER.—I ask if he is to be *ex-officio* a member or in place of Mr. Decker.

MR. ESPY.—I mean that he should act in the place of Mr. Decker.

The motion of Mr. Espy was then seconded.

Mr. Gardner put the motion, which was carried.

The Committee on Revision of Constitution was then announced to be Mr. J. M. Diven, Mr. Peter Milne, Mr. William Ryle.

THE SECRETARY.—I would like to ask for the benefit of the stenographer and the reporters that are here, that when a gentleman makes a motion or wishes to take part in the discussion, that he will always state his name. It facilitates matters very much for the stenographer in taking the proceedings.

THE PRESIDENT.—We will now proceed to the next order of business, which is a paper by Mr. J. Nelson Tubbs on "Particulars in which Municipal Officers should

protect the Municipal Corporation in granting Water Works franchises to private water companies."

The Secretary then read the paper, as follows:

PARTICULARS IN WHICH MUNICIPAL OFFICERS SHOULD PROTECT THE MUNICIPAL CORPORATION IN GRANTING WATER WORKS FRANCHISES TO PRIVATE COMPANIES.

BY J. NELSON TUBBS.

The fact that considerable more than one-half the water works plants in this country are owned and operated by private Companies, is sufficient excuse for the title of this paper, but a somewhat extensive professional examination of franchises of this character has satisfied me that very few of them contain such provisions as fully protect the rights of either the grantor or grantee.

As a matter of common knowledge it may be assumed that it is the expectation of both the municipality and the company, that the city or town will ultimately become the owner of the water works property and sooner or later, in almost every instance, this expectation is realized. Such being the fact, it requires no argument to prove that the franchise granted should assure the construction of such a plant as the municipality can afford to purchase, or in other words, such an one as shall fully supply its needs and minister to its growth and prosperity.

As a general proposition, I therefore assume, that in preparing to grant a franchise to a private Company, the preliminary action of the municipal officials should be exactly similar to what it would be in case the works were to be constructed and operated by the municipality. The usual and proper action in the latter case would be to secure the services of a competent hydraulic engineer to make a thorough examination of the whole subject and to prepare a detailed report as to the quantity and quality of water required, the best source of supply, the best plan for obtaining the same, the head under which it should be delivered to private consumers and to the municipality for the suppression of fires, the size, character and quality of the mains to be employed and the required performance of the pumping machinery if such is to be used.

With this detailed information in the hands of the officials, they are prepared to advertise for proffers and to grant a franchise, which will require and insure the construction of such a set of works as will fully meet the requirements of the municipality and one which it can afford to purchase at any time and pay a reasonable price therefor.

IMPORTANT DETAILED PROVISIONS WHICH SHOULD BE EMBRACED IN THE CONTRACT CONSTITUTING THE FRANCHISE.

1. The minimum *quantity* of water which the source of supply shall be capable of furnishing in a dry season, or a succession of them. This determination with reference to any proposed source to be made by the Consulting Engineer of the Municipal corporation.

The importance of such a provision is obvious, as the daily minimum

supply which can be obtained, should be sufficient for the needs of the municipality for a period of at least twenty years. Any failure in quantity might result in serious loss to the town in case of a purchase of the works from the Company, coupled with a subsequent discovery that the supply was inadequate for the increasing population. It is perhaps unnecessary to add that in the opinion of the writer, the required quantity should not be less than 100 gallons per capita per day for the estimated population at the expiration of twenty years.

2. The methods by which the *quality* of the water shall be determined, should be definately stated, together with the general charateristics required. Of course this determination depends upon the results of chemical analysis and bacteriological examination and also upon a critical and intelligent personal study of the contributory watershed, to settle questions of possible future contamination.

3. The right should be reserved to the town officials, under the advice of the consulting engineer, to determine the size and character of the conduit which is to conduct the water from the source to the town or city.

This detail assumes the more importance from the fact, that in many cases it becomes desirable, that for the purpose of increased pressure at fires, the plant should be temporarily converted into a direct pressure system, by shutting out all connection with the stand pipes or reservoirs, in which case the conduit is required to convey water not only at the rate of the average consumption, but also in addition, at the rate at which water may be used for the suppression of the conflagration. This fact has an important bearing upon the determination of the required capacity of the conduit.

4. In case pumping is required, general specifications should be inserted, which shall determine the general character of the engine and boiler house and chimney, the character and capacity of the boilers, the general characteristics, capacity and duty of the pumping engines and their adaptability to perform the particular service required.

5. The capacity and characteristics of the stand pipe or reservoir should also be settled, leaving the final determination as to the sufficiency and adaptability of the several details of site and construction to the judgment of the Consulting Engineer.

6. The franchise should reserve the right to the municipal officials to determine under proper conditions and under the advice of their Engineer the character of and particular location of the pipe mains in each street or place, the depth at which they shall be laid below the established grade of the streets and the number, location and style of the gates, fire hydrants and other fixtures to be connected therewith.

In connection with this clause should be inserted a detailed specification of the material forming the pipe, its method of construction and the details for laying the same.

7. The determination of the sizes of the several mains should be reserved to the municipal officials acting under the advice of a competent engineer, who should be allowed to carefully adjust the same to the probable economical uses and requirements of the same for present use and future extension.

8. The material and workmanship constituting the service pipes laid in the streets and the manner of filling the trenches and restoring

the improvements over the same, should be carefully detailed in the contract constituting the franchise. The requirements in relation to restoring improvements when interfered with at any stage of the work, should be detailed and the town protected from any accident to person or property resulting from work done by the Company or its interference with the streets.

9. Provision should also be made for maintaining the integrity of all existing subterranean conduits of whatever name or character, whether the property of the municipality or otherwise.

10. It should definitely state the terms and conditions on which future extension or enlargement of the works shall be made.

11. It should define the tests which are to be successfully made as a precedent to the acceptance of the completed work, as in practical conformity with the terms of the contract on the part of the Company and before any sums of money are paid under the contract.

These tests should consist of an internal pressure of at least 100 pounds per square inch applied to the pipe distribution and fixtures for a period of at least one hour continuously, without causing leakage of water or rupture of any of the parts. The test of capacity to suppress fires should be equal to or exceed the severest test which is likely to occur in the practical operation of the works, even under unusual and unexpected conditions. The duty test of the engines should be a continuous one of not less than two days in duration conducted under the direction of a hydraulic engineer hired by the municipality.

12. The franchise should contain a detailed schedule of the maximum rates which may be charged to private consumers of water during the life of the agreement.

13. The limit or life of the franchise should be definitely settled and should not probably exceed ten years as a maximum. Provision should also be made for extension of the time limit of the franchise, at end of prescribed term, if desired by both parties.

I am also inclined to the opinion that the franchise thus granted should as near as possible be an *exclusive* one for the determined period.

14. It should be definitely understood, agreed and stated, that in case the municipality shall elect to purchase the plant at the termination of the time limit of the franchise, that it shall not be held liable to pay anything for the franchise itself, or good will of the business.

It seems to the writer, that in the nature of things the municipality does not and cannot sell or permanently alienate the franchise itself. It is an inalienable function of the government and the municipality can only lease for a valuable consideration the right to temporarily exercise the rights and privileges of the owner and at the termination of the grant or lease, the municipal corporation resumes the active exercise of this function, which had been temporarily entrusted to an agent.

It logically follows of course, that in accepting a franchise under such conditions, the grantee shall receive such terms of compensation as shall render his enterprise reasonably and beyond peradventure remunerative, in case the grantor shall elect not to extend the franchise beyond the first named time limit.

15. The franchise should also contain a provision which should detail the methods which shall be employed to determine the sum of money to be paid for the plant by the municipality, in case it shall elect

to purchase the same at the expiration of the time limit and the several items of the property should be enumerated, which are to enter into the account and on which values shall be placed, but as before indicated, the value of the franchise or any supposed increase in its value should be rigidly excluded, because the franchise itself has never ceased to be the property of the public.

16. Finally and generally, the franchise should contain such comprehensive as well as detailed provisions as shall insure the designing and construction of such a system of works as shall be thoroughly well adapted to the present and prospective uses and needs of the public and also assure their management and administration on economic principles and along business lines.

It seems to the writer, that any water works plant constructed and operated under the provisions of a franchise such as is heretofore indicated, would have the following manifest advantages over the many plants carelessly designed and constructed in the past, and operated by companies viciously organized and loosely or dishonestly administered.

a. A system of works thus designed, constructed and operated would thoroughly meet the wants of the municipality and would command its confidence and it would thus have no hesitation in purchasing the plant at a valuation, being assured of its permanent substantial value.

b. Such a system would furnish abundant safety to investors in its secureties and make them "gilt edged" in the market.

c. It would in case proceedings were instituted by the municipality to purchase the plant, eliminate all those usually perplexing questions of alleged imperfect design and construction, which are ordinarily relied upon to depreciate the market value of the water works property.

d. Such a franchise would furnish a ready standard to which could be referred for settlement all questions or differences involving the relative rights, duties and responsibilities of the company on the one hand and the individual citizen and the municipality on the other.

e. An examination of the provisions of such a franchise would render it a comparatively easy matter to determine upon such a compensation for public uses of water, which with the probable receipts from private consumption would render the investment a safe and remunerative one for the company and at the same time not oppressive upon the municipality, considering the benefits received.

This paper is not written for the purpose of creating a prejudice against, or to excite antagonism towards private water works companies. Their mission has been in many instances a useful and beneficient one, inasmuch as by their efforts it has been rendered possible for many financially weak municipalities to enjoy the protection to health, life and property which an abundant supply of pure and wholesome water always insures. By the enterprise of these companies, the ignorant have been educated, the sluggards vitalized and the blessings of pure water brought into the daily living of untold thousands many years in advance of a natural public awakening on the subject. The intention of the writer of the foregoing has been rather, to indicate in some detail, a method by which, it seems to him, the best interests of both the private company and the municipality may be conserved and the whole business

relieved to a large extent of its purely speculative features and relegated to the domain of legitimate business enterprise.

THE PRESIDENT.—You have heard the paper of Mr. Tubbs. It seems to me that it is about time for a little discussion. This looks like an opportunity.

MR. SAWYER.—I wish the President himself would address the Association. I agree it is a paper to be thoroughly discussed and criticized, and I know of no one so competent as our President. I wish the President would express his views on this paper. It ought not to go on our records without being thoroughly criticised. I take issue with some of the statements the gentleman makes.

THE PRESIDENT.—I would like to have you discuss some of the statements, Mr. Sawyer.

MR. SAWYER.—I hope the matter will be discussed, but I do not feel competent to do it. He says, among other things, that the terms upon which the public may take away from a private company the property which it has constructed by virtue of a franchise shall be clearly defined in the franchise. In many states there is a law which provides that the municipality may take away the franchise of a private corporation, and prescribes the manner in which it may be done. The idea of a paper of this kind is to create the impression that all private corporations are inimical to the public. Of course this is a mistaken idea. There are lots of people enjoying good water-works, and other public works, constructed by private companies. Oftentimes the municipality has failed to make a success of it, and it has said to these private parties we will give you a franchise if you will risk your personal money in this enterprise. Consequently, private parties have gone on and constructed public works of great service to the locations where they have been established. They have charged but fair prices. If the investment does not pay the public is delighted that the private parties have constructed the works; but let it be understood that by good management, good luck, or for any other reason, that these works which private parties have put their money into are profitable, and the public is at once desirous of controlling these works themselves. I do not think a feel-

ing should be excited that as soon as these works become a success that it is possible for the public to assume control of them.

Mr. Milne.—Mr. Chairman, I do not understand that to be the purport of Mr. Tubbs' paper at all. I do not think the sense of his paper intimates for one moment the idea of establishing anything but a cordial relation between the municipality and the water company. The idea contained in the paper, it seems to me, to be that Mr. Tubbs desires to anticipate the possible future development and growth of any water company and what may be required of it. It strikes me that is the feature of the paper. Mr. Tubbs and I had an interesting conversation in Syracuse on the question of what constituted the value of a water plant. The side that I was on happened to be the water company; the side that Mr. Tubbs was on happened to be the municipality. A commission had been appointed to condemn the property and plant of the Syracuse Water Company. Mr. Tubbs was no doubt animated by the best of motives, but took views which differed from my own and those associated with me. I believe the experience evolved in that controversy have led to the consideration and maturity of that paper, and Mr. Tubbs in many respects is right. Gentlemen, we must not shut our eyes to truths. Truth is simply evolved by experience. A water plant may be organized for the supplying of ten, fifteen or twenty thousand people; the most liberal terms may be made, and it fulfills all the wants of that population. The population increases, more water is wanted, and it is not every water company that anticipates the wants of the people. They have to be educated. The idea is to anticipate the possible contingencies that grow out of experience in water works. The trouble is more with water works than it is with the people. You must anticipate their wants. The people you must satisfy.

The President.—I think for my own reputation I had better state that I only knew Mr. Tubbs' paper by the title when I wrote that portion of my address that touched on this subject. I think he has presented some conditions under which we would hardly care to take a franchise. He says that the value of a franchise

should not enter into the matter. I do not think this is right. The private company or private capitalist invests his money and goes through the first ten years—the trying years of a water company, whether private or public, and he educates the people to the use of water and to the value of it, and it seems to me that this is a part of the franchise for which he should be remunerated.

Mr. Espy. I represent a private corporation. The idea, as I understand it, that the author of this paper desires to bring forward is this, that when a charter or franchise is granted there should be included in it the right of the municipality to take it at any time. Now you take the company that I represent, and after ten or fifteen years of hard struggling it has succeeded. The company is in a paying condition. Along comes the municipality, because they have a right in the charter, and takes the plant from us just when it begins to pay and after we have gone through the hard struggle. I do not think there is any point in the argument that the municipality may take charge of those water-works in order to prepare for an increase in the population. I have never seen a water company but what is always ready to do that. They are ready to meet these conditions every time. They have increased the water-works with the population, and I do not see why, after a water company is able to pay twelve, fifteen and twenty per cent., the municipality should have any right whatever to take them from the private individuals who have made the water-works a success. Therefore I am opposed to this paper. I do not believe it is correct in principle at all. I do not believe that after a water company has struggled and manipulated; and managed, and succeeded, that they should have their corporate rights at the mercy of any municipality whatever, in any such way as stated. It is true, as the gentleman says, that just as soon as private corporations begin to succeed then the municipal corporation is against the private corporation. It is so in my city and I believe it is so in every city that is represented here. They want our surplus fund in their own treasury and therefore I do not believe that any charter or any franchise ought to be accepted in which the right is reserved to the city or to the mu-

nicipality of taking that charter away from any private corporation.

Mr. Wanner.—A great deal may be said on both sides of this question, and I will say right here that the public needs no protection in that line and particularly not, it seems to me, from a body of this kind. We are all more particularly interested, I believe, in the other direction. The public, in all these enterprises, is fully taking care of itself. Everybody is trying to take care of, everybody is trying to advocate the interests of, the public. Go to the New York State Legislature and you will see it ; go to that of Pennsylvania and you will find it there, and at every State Legislature in the country it will confront you. You will see it at Washington. Everywhere you will find willing hands trying to lift up the public. It seems to me that, in that view, this article was probably uncalled for. Still it brings about a discussion, and it will stand or fall upon its own merits, particularly so far as the members of this Association are concerned. I know of no enterprise where greater hardship is imposed upon brains, energy and capital than in the building and management of water-works throughout the length and breadth of the land, by corporations or individuals. As far as I know, in all the States of the Union, provision is made in the charters or franchises whereby water-works can be taken either at any time or at a certain time. Take the laws of Pennsylvania, for instance; the act of 1874, under which the present corporations were constituted, stipulates particularly as to water-works, that at the end of twenty years these enterprises will have to be, if wanted, handed over to the municipalities, and all that can be asked is the amount of the money expended, with ten per cent interest. There is not much encouragement in an enterprise of that kind, after you have passed the best years of your life in the labor of building it up and in many cases risking everything, probably more than you had, more than you owned ; and after all this, all you can recover in the end is the amount you expended and ten per cent for twenty years. The conditions in this State may be the same or worse. We see, however, the public is taken care of everywhere, and needs no help from this body. That is the way I look at it. Still it is a matter for considera-

tion and discussion. The truth will always prevail and I should like to hear it discussed by others that are here. I believe in private water-works and I respect the men who come forward and do their duty in that direction—give their time, attention and capital and run the chances of loss. It is only after the water-works have been made to pay, when they have been raised up to the remunerative point—and it is only after years of labor and energy that this can be done—that these people come in, demand and take them. The public, as before stated, is well taken care of, and it seems to me a body of this character should rather take the other position and care for the men who put forward their energies, abilities and capital in such improvements.

Mr. Crosby.—I may be a little out of order in offering suggestions, not being a member of the Association. If so, I do not care to say anything.

The President.—I think the Association will be glad to grant you the privilege.

Mr. Crosby.—I do not draw the same conclusions from this paper that some of the gentlemen who have just spoken have drawn. I will say a few words on this subject from my experience. We now have a law-suit in the city where the plant in my charge is located. The city had the privilege of buying our works at each recurring period of five years, but the city and the water company not being able to agree upon what constitutes the works the city had elected to purchase, the question has now been in the Chancery Court for nearly two years. I think there is a good deal that is important in this paper regarding franchises, etc. I believe Mr. Tubbs has thoroughly covered all the points. One of the speakers has the impression that as soon as a water-works company is on a paying basis that then the public would take the works away without proper compensation. It strikes me that the author of the paper has provided for just such an emergency as this in defining how the works shall be built and what they shall cost, and for the profits which would accrue if the works continued in the possession of the company. Where this is done it would not be necessary that any valuation should be put upon

the franchise and good will of the business in case of a sale to the municipality. Had the suggestions of Mr. Tubbs been incorporated in our franchise from the city the difficulties in our case would have been obviated.

Mr. Monjeau.—Mr. Tubbs is a gentleman very well posted, as most of you know; and after hearing the paper I very much question whether he intended to have the idea taken up which has been expressed by the gentleman to my right (Mr. Sawyer) and by the gentleman preceding the last speaker (Mr. Wanner). I feel something like an old professor of mine, who used to begin his rebuttal of arguments, with "I fully agree with every gentleman who has preceded me in everything they say, but—" and then he would proceed to contradict everything that had been said. I think that the comments upon this paper indicate pretty directly the course that we will have to take before we can get at justice. Let us go to the headquarters at Washington, and let Washington send to the several States of the Union and have laws and rules framed under which our right may be protected, and gentlemen who work as the builders of water-works do, after they receive their franchises, may be remunerated. I do not know that you are fully aware that millions upon millions have been spent in this country in protecting towns from fire and in building up new centers of population, in which water-works play so important a part; and that one-half of the original investment in water-works is lost, and the other half getting very little interest. What this gentleman to my right, preceding the last speaker (Mr. Wanner) has said is too painfully true. You will notice that the principles of anarchism and socialism are gradually growing. My good friend in the high-towered building yonder once cut my strongest letter warning my countrymen against anarchy, and said in an editorial comment, "The idea that anarchy should ever thrive in these United States of America" This is over fifteen years ago, but as near as I can remember these are his very words.

Two years later, I believe it was, I stood on the streets of Chicago and estimated 2,500 men, some in rags, some black with soot from the shops, some with red flags in their hands, most of them with pitchforks and axes, crow-bars, swords and all manner of implements

of destruction, with the intent of the protection of what? Please tell me; I do not know. There is danger, great danger, that capital, sensitive as it is, will retire, and it is retiring very fast. I am surprised that I do not see in this audience gentlemen who are attendant upon the meeting of this Association from a distance, three or four gentlemen who are capitalists and who are interested in the sale of water-works. There is great danger; our people should be protected. That is all right. I agree with the legislators in the several States and at Washington, the people should be protected; but as a rule they protect themselves, even to the statesmen—believe me they are protecting themselves. I think there is great danger of capital not being protected. There is much greater danger in this. I must say that I appreciated the paper before I knew who had written it. I appreciated it as a good, strong, worthy paper, with few exceptions, such, for instance, as indicating beforehand what the works shall be worth, or what shall be paid for them when the city or town takes hold of them. I do not think that is practicable; and as to providing twenty years ahead for any American community, especially in the West, it is simply a dream. No one acquainted with the territory beyond the Mississippi would ever suggest anything like that. The city of Omaha has been twice provided, and yet they are under the necessity of making further provisions. I think their works are among the finest in the country.

But, pardon me; I am digressing somewhat. What I wanted to say was this—that we be more careful of capital, or it will surely hide and keep safe. English capital is already hiding from us, and French capital to quite an extent. A good deal of German capital has already withdrawn. The cities themselves are in danger. You know how water committees are constituted, and you know how common councils are constituted. I will not indicate how; you know how. You know that the highest wisdom of the state is none too strong, or well posted, to provide for the protection of our cities and towns, from the machinations of legislators. On the other hand, capital should get at least equal protection with the towns and cities. Let us go to Washington, and let Washington go to the other capitals, and let us

have laws made in a direct open manner, and not by the crooked ways that so often obtain in securing franchises.

THE PRESIDENT.—Is there any further discussion on this paper?

MR. BRUSH.—Before proper laws can be framed and passed and executed, public opinion must be educated in order to make these laws possible and effective, and therefore discussions must take place, not only in conventions of this kind, but in local assemblies other than scientific bodies. Naturally, scientific bodies will lead in the discussion.

The true test of the value of a principle is its practical application. A series of principles have been laid down in the paper before us. The idea of Mr. Tubbs is, that any private corporation attempting to supply a municipality should be restricted as to the time of its operation, and that a price should be allowed to the corporation, which would be commensurate with its expenditure and which would enable it to do a profitable business during the limit of its franchise. As has been well stated, it is utterly impossible in any ordinary district, to work up a business in connection with water works that will be self-sustaining in much less than ten years; not infrequently it runs to fifteen years, and yet the franchise is often limited to ten or twenty years.

Acting on the general principle advocated in that paper, the price charged for water—the water rates—should be sufficiently high to make good the loss that takes place during the early years of the inception of the enterprise, and also to insure a reasonable return on the capital invested. The water rates should be based on the idea that at the end of the period a reasonable remuneration should be paid to the water company for the expense which it has incurred in the construction of its plant. Now, as a matter of fact, what is the practice? The first question discussed is that of rates, and in order to determine what is a proper rate, the reports are examined of the largest cities in the vicinity which have water works in successful operation, but which were built at a loss, and run at a loss for a number of years either by private parties or by municipalities. The rates

ascertained, the water company is told, these are the rates which are paid in other places—"Of course you do not expect any more." That is the first practical operation, and the result is that the rate which the water company has to take, is a very large discount on the rate which it should receive in order to make good the losses of the first few years of its existence, and to allow a reasonable return on the investment. And then comes a second phase of the question, about which the public need a decided education. It is this: the moral sense of some portions of our community is such that when it comes to determining the value of a water plant after it has been in existence a limited period, as ten or twenty years, the public are unwilling to allow a reasonable compensation for the plant and no allowance is made for the losses incident to the operation of earlier years. In one marked case before the public the city has kindly offered the water company one-tenth of the cost of the plant which the company built under its franchise; and the city seems surprised that the water company is not prepared to gratefully accept its offer. In another case, in a different part of the country they have not gone even to that extent but the community has deliberately proposed to parallel the works of the water company, to which it gave a ten-year franchise, and has practically said to the water company, "Now we will work in competition, and in that way our citizens will obtain a benefit which they would not otherwise receive." Now, until the moral tone of a community can be elevated, we cannot hope to pass such laws as have been proposed, and see that they are properly executed. On the other hand, I am confident that a plain, frank, statement showing just exactly the meaning of such municipal dishonesty, is sufficient to make the people of this country understand that they do not want to go into business of this kind.

This closed the debate on the paper.

The President.—There being no further remarks on the paper of Mr. Tubbs, we will now hear from the Chairman of the Finance Committee, who was not here at the time the report of that Committee was called for, but who has since come into the room.

The report of the Finance Committee was then presented, as follows:

NEW YORK, May 17th, 1892.

To the Members of the American Water Works Association:

We, the undersigned members of the Finance Committee, hereby certify that we have examined in detail the accounts and vouchers of the Secretary and Treasurer and have found the same correct.

JAMES P. DONAHUE, Chairman.
WILLIAM MOLIS,
WILLIAM RYLE.

Mr. Richards moved that the report be received and adopted. Carried.

The Secretary announced that those desiring tickets for the theatre party Wednesday night, must call at the room of the Secretary of the Local Committee immediately after adjournment this afternoon and register their names and state the number of tickets they will need.

THE SECRETARY.—I wish further to say, as regards the registration of certificates, to all the members who have not had their certificates registered, that it is absolutely necessary that they should attend to this at once. This should be attended to this afternoon, because the gentleman who is here representing the Traffic Associations, at a cost of $11 a day to this Association, will be here to-morrow to vise these tickets. Every ticket must pass through his hands and be signed by him, or it will not be accepted at the railroad ticket office. It is an expensive luxury to have him here, and we do not want to keep him any longer than is necessary.

THE PRESIDENT.—Mr. Halloway of the Local Committee has something to announce.

MR. HALLOWAY.—Mr. President and gentlemen—I desire to make an announcement on behalf of the American Society of Mechanical Engineers. Some of you are members of the society; others are not. The society is at present holding a meeting in San Francisco, and the Secretary is with them. Before they went away they authorized me to say to the gentlemen who attended this convention that they would be very glad to

have you visit their club-house at 12 West 31st street, while you are in the city, and avail yourself to any extent of the facilities which it may afford. There is an extensive library there; and I am quite sure gentlemen who find an hour of leisure to go there, will be very welcome, indeed; and I make this announcement on behalf of the Secretary, for the reason that he is in San Francisco and cannot do it.

THE PRESIDENT.—You have heard the invitation on behalf of the American Society of Mechanical Engineers. What is your pleasure in the matter?

MR. ESPY.—I move the invitation be accepted and a vote of thanks extended to the society. Carried.

MR. BRUSH.—Mr. President and gentlemen—As Vice President of the American Society of Civil Engineers, I wish to say that we would be glad indeed, to meet you at any time at our house 127 West 23d Street, and especially to-morrow night, when the regular semi-monthly meeting will be held, any of you who have no other engagements and would like to attend that meeting will be cordially welcome. The house is open during all hours of the day, and at any time you are welcome to come to enjoy its hospitalities. So much for the American Society of Civil Engineers.

I see you have a very full program, and I have no doubt that a great many courtesies have been proposed, which the Local Committee would have been glad to have extended to you if time had permitted. I do not propose to obtrude any courtesies upon you that would interfere with the arrangements of your Local Committee. I notice, however, that your morning sessions do not commence until ten o'clock, and I have no doubt that you are all early risers. We have some points of interest not mentioned on this programme, which we would be glad to have you see. The West Shore Railroad ferry runs from the foot of Jay street, and the foot of West Twenty-third street every fifteen minutes during the day. This ferry takes you direct to the West Shore depot in Weehawken. At the West Shore depot in Weehawken are the largest passenger elevators probably in the world. They are the most powerful.

They were built by the Otis people; the same concern that built the elevator in the Eiffel Tower in Paris. There are three elevators each of which will lift 140 persons 153 feet in forty five seconds. From these elevators there is a trestle 150 feet high, and about 900 feet long, connecting the elevators with the bluff of palisaides. The elevators are within 200 feet of the ferry house. At this point, the most extensive pleasure grounds in this section of the country, known as Eldorado, are to be seen, and the view of the New York harbor and bay is something that is unique. Immediately beyond these grounds are the high service works of the Hackensack Water Works Company. These works contain a number of objects of interest, a tower 150 feet high, with a tank on top, and from these high service works are supplied the whole of the heights north of Jersey City. In this tower will be found a high duty pumping engine, just erected, and which has some rather marked peculiarities, one of which is that we run readily the engine at one-tenth of its capacity. Connected with this plant is an aeration plant which the company has in operation, whereby the water in the reservoir is aerated. At the reservoir you will see the first of the Freeman meters which has ever been erected. The Freeman meter as you know, is nothing but a large hose nozzle, and the theory of it is, that by the contraction of this nozzle and the noting of the pressure, the determination of the charge can readily be obtained from a table which Mr. Freeman has calculated. It certainly is unique, and very simple; and if you are interested in that class of work, you will have an opportunity of seeing it in operation. If any of your number will fix any time when they can go there, I will be happy to accompany you. If it is not convenient to go in a body, all that you have to do is to show your badge as you cross the ferry, and the courtesies of the West Shore road will be extended to you; show your badge as you enter the elevator and the courtesies of the North Hudson County Railway Company are open to you; show your badge as you enter the railway train on the elevated structure and you can ride the whole length of the road.

The President.—We will take action on the first announcement of Mr. Brush, the invitation to attend the

meeting of the American Society of Civil Engineers at eight o'clock to-morrow night.

Mr. Ryle.—I move that the invitation be received, with thanks. Carried.

The President.—As to the second matter, it is a very interesting trip that Mr. Brush offers us, and I think some arrangement should be made so that a considerable number of the early risers can go over there to-morrow morning, or at some other time.

Mr. Sawyer.—How many hours will it take to make this trip?

Mr. Brush.—There is a boat that leaves the foot of West Forty-second street at 8:25 a. m.

Mr. Sawyer.—Suppose we get a lot of the boys out at seven o'clock, is there an earlier boat?

Mr. Brush.—There is a boat at 8 o'clock; but the 8:25 boat will give you plenty of time. It is only a short distance across the river, and everything can be seen there and we can be back by the opening of the meeting.

Mr. Sawyer.—I have no doubt that quite a number would like to accept the invitation, and we would like to know if you will accompany them.

Mr. Brush.—There is a boat that leaves at 8 o'clock. If you will take that boat on Thursday morning, instead of to-morrow morning, I can agree to have you back here at ten o'clock. I am not sure that the time is exactly eight o'clock; but I think it is about eight. I will make the arrangements and announce in relation thereto later.

Mr. Wagner.—I move that we accept the invitation, and that as many of the members as can will attend in a body at such time as may be arranged, so as not to conflict with our regular programme.

THE PRESIDENT.—I think it would be a good plan for those who intend to go to register at the Secretary's Office.

Mr. Wagner's motion was seconded, put and carried.

MR. MONJEAU.—For the sake of peace and good will among all concerned, do you think it would be necessary to make a motion that the paper of our brother Mr. Tubbs, be returned to him with a statement of the criticisms which have been passed, some of which may be a misunderstanding, or result from some misexpressions of his, to enable him to correct any mistakes before it is published. Do you think it would be necessary to make a motion, to give you, Mr. President, or the Secretary, or the Committee, the privilege to do that? It is only a suggestion.

THE PRESIDENT.—I think the Secretary has the privilege to do so, if he sees fit.

MR. BENZENBERG.—I should hope that no paper submitted here would be refused a place in the printed proceedings of the Association. It seems to me this would be a reflection that the members would not undertake to cast.

THE PRESIDENT.—That could only be done by a vote of the Association.

MR. BENZENBERG.—I do not think that Mr. Tubbs intended to have the paper convey the impression that seems to have been accepted by a number of our members. It has simply been written with the idea of making a basis for a fair treatment on both sides, not to criticise either one party or the other, but merely as a suggestion of a fair basis of understanding and agreement between the two sides; nothing more or less. I hope that no action will be taken that would look to a rejection of this paper.

MR. BRUSH.—I heartily sympathize with the last speaker. Nothing that I have said should be construed at all as meaning anything more than exactly what was intended by the paper, that is, the personal expression of different people in relation to what should be done in

connection with this question. I think the paper is a valuable one. I think it should be printed exactly as it has been presented. It has brought out the only discussion that has taken place to-day. The value of any paper is governed by the discussion that follows it; and to my mind the question has been opened by that paper probably in a better way than it could have been done in almost any other way.

THE PRESIDENT.—I think the paper could not be rejected except by a vote of the Association. I think there is nothing objectionable in it.

MR. MONJEAU.—Allow me to reply that there was not the remotest intention on my part to have the paper rejected. My desire was to avoid having a member of this Association appear in any other light than that in which he intended to appear.

MR. WANNER.—Whatever the merits of that article, I want it to stand as it is. I would not ask that it should be withdrawn, or even too severely criticised. We all have our opinions upon these subjects, and it is proper that we should express ourselves. In this free country of ours, full of associations like this, where matters of public importance are discussed, and in these days when we have unusual facilities of education, I believe it is exceedingly proper that these matters should be brought up and discussed; and then let such matters like this stand upon their own merits.

THE PRESIDENT.—There seems to be no further business. I wish to say that there will be a reception here at 8 o'clock this evening by the city officials and prominent citizens. The ladies and guests are all expected to attend. The reception will be in this room. There will be music and a collation. We shall expect a very much more prompt attendance than we have been able thus far to secure.

Adjourned.

SECOND DAY.

Morning Session, Wednesday, May 18.

The President called the meeting to order at 10:25 a. m., and announced the first business in order to be the calling of the roll, which was dispensed with.

The Secretary then presented the following applications for membership:

FOR ACTIVE MEMBERSHIP.

William E. Hawks, Sec. and Treas., Water Works	Bennington, Vt.
John U. Schrotch, member Water Works Board	Rochester, N. Y.
George W. Aldrich, Pres. Water Works Board	Rochester, N. Y.
George P. Orcutt, Supt. Water Works	Orange, N. J.
Willis P. Tharpe, Supt. Water Works	Cincinnati, O.

FOR ASSOCIATE MEMBERSHIP.

Dayton Water Works	Dayton, O.
Board of Water Commissioners	London, Canada.

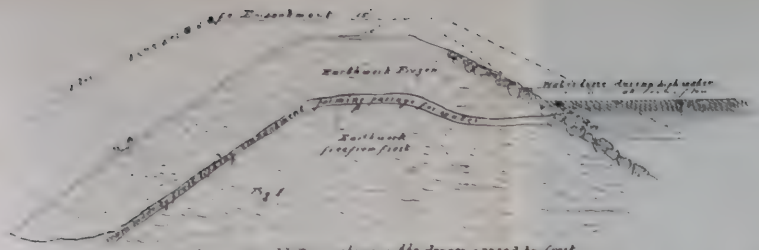
The President.—You have heard the names of the candidates, gentlemen; what is your pleasure?

Mr. Clayton.—I move the Secretary cast the ballot of the Association for the candidates. Carried.

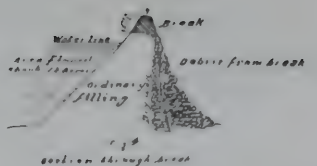
The Secretary.—In accordance with the vote passed I herewith cast the ballot of the Association for the candidates named.

The President.—Are there any reports of special committees this morning? There seems to be none. According to our usual custom, I will appoint the following gentlemen a Committee to make nominations for officers for the following year, to be elected Thursday afternoon: L. H. Gardner, New Orleans, La.; C. N. Priddy, Leadville, Col.; R. G. Holden, Nashua, N. H.; Wm. Ryle, Paterson, N. J.; W. G. Richards, Atlanta, Georgia.

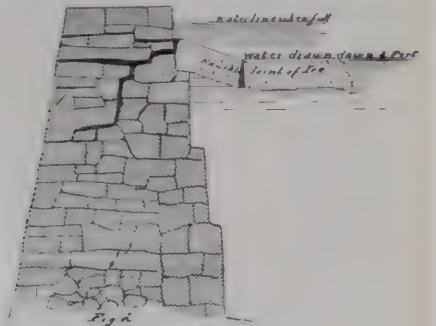
The Committee will report Thursday afternoon.



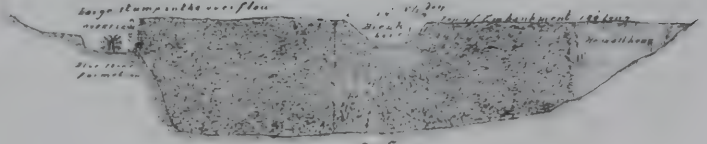
Section of Earth Dam showing the danger caused by frost

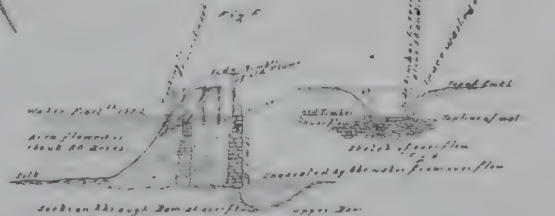


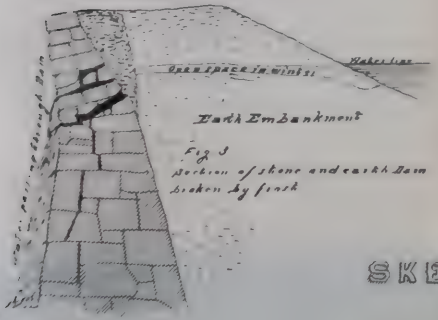
Section through breach



Section of Dam showing effects of ice heavy shade shows crack







Section of stone and earth Dam broken by frost

Elevation shaded portion shows where it has washed away

Figures 4 & 9 are sketches of Dams at Laurens NY

SKETCHES OF DANGEROUS DAMS

BY W B RIDER S NORWALK CONN.

THE PRESIDENT.—If there is no further business, we will proceed to the reading of papers. The first paper on the list is "Reservoir Dams," by Mr. W. B. Rider, South Norwalk, Conn.

Mr. Rider read the paper, as follows:

RESERVOIR DAMS.

BY WILLIAM B. RIDER, C. E.

It is only by special request that I have consented to write a few words on the subject of reservoir dams. Being a comparatively new member, I feel it my duty to listen to those who are older and whose experience has covered a broader field. I will not attempt here to discuss different formula and their so-called factors of safety, which could in many instances be properly called factors of error, nor the details of plans, for they are as numerous as the reservoirs themselves and each fitted to the fancy of the designer.

The construction of dams has been carried on for centuries by man and animals, specimens of both remain to-day, the age of some none can tell.

The main feature of a dam or embankment is its safety, not merely strength enough to hold the water back, but it should be able to resist other elements, among which might be mentioned, "Jack Frost," eels, heavy freshets, ice, heavy floating substances, etc. To guard against the frost, the top of the embankment should be high enough to prevent it from penetrating down to the water line of ordinary spring freshets.—See sketch, fig. 1.

When the frost reaches below the water line there is an opening made, by the frozen embankment being raised, and the water will pass directly through the dam, and when once started a few moments will see the entire structure washed away. It is therefore necessary to have the embankment of such a height that the bottom of the frozen section will be a safe distance above the water line. A cemented wall or core will prevent serious disaster, but even this is often lifted and cracked at the frost line. From observations made, I am inclined to believe that more leaks and breaks occur through the action of frost than from any other cause. A stone masonry dam constructed strong enough to resist the pressure of the water often will fail from the same cause, especially is this the case when the water varies in height.—See fig. 2. Assume the water to be at its full height and then freeze several inches in thickness, at this period the amount used is generally greater than the amount entering the reservoir. And the ice falls at the edges, and here let me call attention to that portion adjacent to the wall, the ice, a short distance out, (usually about six inches) cracks. Beyond this at the edge of the water it cracks again, on the surface of the water it, of course, remains level. The cracks then freeze solid, taking up the space made on the slope by the water receding. With this condition and a spring thaw, the water rises and forces the sloping ice in the form of a knuckle joint lever against the wall and forces it to yield in spite of granite blocks and

hydraulic cement. In several instances I found the above to be the direct cause of the failure.

The quite common method of building a wall and backing it with earth on the up-stream side should not be sanctioned, for the earth, expanding in freezing will crack the wall and in many cases it will, in a few years, be pushed over. No matter how well laid.—See sketch, fig. 3.

In most cases, there is waste material enough thrown away, which if placed on the lower side of the wall, would properly protect it, and at the same time the strength of the dam would be increased, at a slight additional cost. All dams or reservoirs intended for winter use would be safer with an earth embankment on the up-stream side than without it, and they can generally be built as strong and more durable and at less expense than a stone dam.

As to eels, I have never found them working very far into a good puddled embankment, or over three feet below the original bed of a stream. They generally find their way in clay or loam embankments. A few barrels of lime placed along the foot of the slopes will prevent them from working through the dam and causing it to leak. As to freshets to much care cannot be exercised in providing for them. Overflows or waste wiers ample in cross section should be provided, and, whenever practicable they should be located as far as possible from the main dam. I have in several instances placed the wier in a separate ravine. I have found that, in Connecticut, a waste wier five feet deep and ten feet in length for each square mile of water shed is necessary in time of heavy freshets. The largest freshets generally occur in April when the nature of the soil is such that it will not hold or stand the strain it would later in the year. It is good practice to place timbers on a slope of about two feet in ten from the crest of the overflow into the reservoir, this allows floating ice and other substances to slide over, instead of striking a severe blow against the dam.

As to the type of dam, no two places are alike and the engineer must use his judgment, and not follow any particular design. The great tendency in this important line of work is to award the contract for the construction to the lowest bidder, regardless of the contractor's experience and at his low figure. Though the engineer knows well that the work cannot be done for the amount. And often in such cases the engineer will be condemned for doing his duty in enforcing the terms of the contract. Could I have the power, no dam or reservoir that was to hold a large volume of water would be constructed except by days work. Any city can, with good advice, do the work as cheaply as any contractor. While I do not mean to refer to any particular work or contractor I have seen (during the construction of a stone dam costing nearly $40,000, and supposed to be laid in first-class manner), several loads of dirt, sand, mud, and water washed into it during the night. In another case, stumps, bowlders and other material were dumped into a supposed puddled embankment. In another case a lot of hemlock brush were placed in layers in the embankment, and covered with dirt, on being asked the reason for doing such work the contractor replied, "That it prevented his teams and carts from miring into the bank and he thought that it would mat together and make it stronger." The dam gave way before the reservoir filled, as might be expected.

The dams that have stood the test of freshets, frost, etc., the longest are the old fashioned log dams, next come the stone and earth dams, with shingle masonry overflows.

The largest dam in Connecticut of the timber type is on the Farmington river, built in 1847. This is a timber dam standing on a quicksand bottom. The spillway or overflow is 232 feet long and frequently water flows over it six to seven feet deep. This dam was originally twenty-one feet high from mud sill to overflow. In 1878 it was raised six feet additional under my supervision. A good description of this dam can be found in Leffel's Book on Mill Dams, a valuable work for all engineers. Whatever style of dam or reservoir is to be built two factors should be looked after carefully. First—To be sure and clean the surface of all poor material of every description, and keep it clean from end to end as the work progresses, until the embankment is completed. Second -carefully select all material no matter what form of embankment you build whether of earth stone or wood.

A few years ago I was called to examine a stone dam that was leaking badly, to see if I could tell where the water passed through. The foundation was of rock at both ends, coarse gravel in the centre. The wall was amply thick and theoretically very strong, but on the ground of economy was built of dry masonry except two feet on the up stream side, this was laid in cement, and faced with cement mortar. Afterwards the outer face received a coat for looks. The inner portion of the wall was built after the cellar wall pattern of dry masonry laid in loosely, being filled in with anything and in any manner, the result was that when the reservoir was filled the water pressed against the inner wall so hard as to compress the dry filling closer together so much it caused the wall on the up stream side to crack badly allowing the water to pass through the cemented portion to the inner or dry section thence downward to the gravel, and into the natural water course below. This resulted in the washing out enough of the gravel in a short time to allow the central portion of the wall to separate in the form of an arch about one-third of the height from the bottom and sixty feet from end to end. Had it been left much longer they would have had an arch bridge instead of a dam. A puddle embankment has been built on the upstream side and saved it. This dam is thirty feet high and three hundred feet long. It is plain to be seen in this case, that a few dollars spent on the excavation for a foundation, and a few barrels of cement would have been much cheaper than the repairs. Careless work of this class has been the cause of many disasters, unscrupulous contractors care nothing for damage or even human life, if they can only palm off their work long enough to have it accepted and get their pay. One more important item requires careful planning at the outset and constant care after the work is completed, although often neglected, and that is the wastewier or overflow. This should be made strong, durable and of sufficient size to allow the largest freshets to pass over it freely. They should be kept free at all times and never allowed to be obstructed in the least. A law to this effect in every state would save thousands of dollars yearly, and many lives, the Johnstown disaster is a lesson not soon to be forgotten.

During the past winter I examined two dams in the worst condition of any that I have seen for a long time. See sketches of dams at Laurens

N. Y. There are three dams located on a stream that runs through the centre of the village, the first is a small one and does not store or hold much water, the second is shown by figures forty-five and six. This dam is 184 feet long and thirty-seven feet high, a portion of the wall has fallen from cause shown in figure three and a gap is formed in the central portion of the dam five feet deep and twenty-four feet in length. To make matters worse, a large stump with fine roots well filled and packed with clay soil is firmly lodged in the overflow, making a very serious obstruction to the passage of water, this dam floods about thirteen acres. The dam was probably built straight as shown by figure six but it has been forced outward as shown and is at present in a very dangerous condition. Above this stands another dam flooding eighty acres, the overflow to this dam is in the centre, the planking is rotten and worn out, so as to allow the water to pass freely and the embankment has already washed out as shown by figure eight. Should these shaky dams give way, the village which lies in the valley a short distance below, would be swept away.

I have made a special report of these dams which had space permitted I should have been pleased to have added hereto. I have not attempted to tell you how you shall build embankments or walls, how thick, or what materials to use, all of these will vary with the locality. The vital parts mentioned at the outset should be looked after very particular. The details of form, strength and material to be used I leave entirely with you. Years ago dams and reservoirs in this country were small and insignificant very little care was used in their construction, they served the purpose for which they were built and gradually gave way, examples of them can be found on every hand. As time passed on the demand for water power increased and the size and strength of dams, as well as their quality increased. In the present age, power is not the principle factor, water must be stored for domestic purposes, and in large quantities requiring larger structures than formerly, and as durable as they can be made. Hence the necessity of using every precaution to avoid disaster and ruin. Those of us who attempt to construct reservoirs to retain water should use and enforce everything in our power to secure safety.

The President.—Are there any remarks on the paper?

Mr. Rider.—If I may be allowed I would like to say a few words further in connection with the paper. The first dam, which on the sketch is figures 5, 6 and 7, stands about a mile below a large dam. This covers an area of about thirteen acres. About a mile above it is another one of about eighty acres. As you will see in the sketch at the bottom, there is an old-fashioned waste-way in the center of the dam. That has been allowed to stand there until nearly every plank has been washed and worn away. There are three planks now in the dam, possibly only two. The water passes through, and not

only are the timbers rotted away, but the bank is also washed away, allowing water to pass freely through it. I expect every time after a freshet to find the embankment in the central portion washed away. Of course, should this happen, the volume of water in the eighty-acre or large reservoir will necessarily flow to the one below, which is in pretty much the same condition as the other. Of course, the results in the case of such a deluge are easy to picture. Unfortunately, in this State, there is no law whereby you can prevent any disaster of that kind. A dam was washed out in that vicinity last fall; there were no lives lost, but several buildings were carried away. This village has a population of about fifteen hundred, lying in a flat below these frail structures. If these dams should give way suddenly they would form a wave five feet in depth. This, of course, would take every building with it. If it should happen in the night time a great many lives would probably be lost. I would like to have you look over the sketches of these dams in particular.

THE PRESIDENT.—I am surprised to hear Mr. Rider state that there is no law in this State supervising the construction of dams. I was under the impression that there was. I appreciate fully what he says about the safety of a dam being in the overflow. I have had some experience and a good deal of trouble in the overflowing line.

THE PRESIDENT.—If there is no further discussion on the paper we will proceed to the next paper, "Distribution Mains and Fire Service," by Mr. J. T. Fanning, of St. Paul, Minn.

The Secretary then read the paper of Mr. Fanning, as follows:

DISTRIBUTION MAINS AND FIRE SERVICE.

BY J. T. FANNING, MEMBER OF THE AMERICAN WATER WORKS ASSOCIATION.

Inefficiency of the water supply is the statement that comes to us again and again as a stereotyped sentence in current reports of large fires. These reports emphasize the fact that it is always important that each public water supply system shall be a good and efficient fire controlling system.

In a majority of the towns and cities that have built water supplies under municipal ownership, it is probable that the desire for fire protection was the strongest incentive to the general public and the chief influence that carried the vote for the issue of bonds to pay for water works.

Fire may be a grand spectacle to one who has no personal interest other than to enjoy its grandeur, it may interest one who studies the plan of contest to control it, but it is a waste for which there is no recompense, a discouragement, as of ill fate, to the loser, and awful in the extreme when human lives are engulfed in the ruin. All the great cities of the civilized world transmit in their histories lurid stories of great devastions, and the sum of fire losses in great fires of American cities alone seems fabulous. A committee of the National Board of Fire Underwriters estimates the average waste of values by fire during the last decade as exceeding one hundred million dollars, and claims that the annual loss is increasing.

Boston has had five great historic fires, St. Louis three, New York two, Philadelphia two and Pittsburgh, Albany, San Francisco, Washington, Portland, Chicago, Lynn, Spokane and Seattle successively, and a host of small cities have seen the fire fiend cut his broad swath through their midst. Are failures so often recurring, due in any large degree to a lack of knowledge of the principles and proportions of a good fire hydrant service?

New fire systems are being constantly planned in the new cities and old systems are being constantly extended, so that it may be profitable to consider just how far the successive steps in planning a new or extending an old system are governed by simple rules, requiring only easy mathematical demonstrations or computations.

FORCE OF HOSE JETS.

The making of a good fire hydrant service is the form in which the problem comes to the young and enterprising city, and the maintenance, the form in which the problem comes to the older city. Towns or cities of less than ten thousand inhabitants have comparatively few three-story or other buildings requiring fire protection, that reach forty feet in height. Cities of ten to twenty-five thousand inhabitants have comparatively few four-story or other buildings that exceed fifty to sixty feet in height, and these heights cover their municipal, court, and hospital buildings. The large cities have buildings eighty, one hundred and twenty-five or more feet in height. As a general rule, streams that have force to reach a vertical height of eighty feet from the ground answers well nearly all requirements of small cities and the suburbs of large cities and also the business sections of cities where buildings do not exceed sixty to seventy feet, say five to six stories in height. The high office buildings of large cities require a special adaptation of fire service.

Our present interest does not extend to such hose jets as were given at the Centennial test in 1876, when 1⅛ inch streams were thrown one hundred and ninety-nine feet vertically, or to such a stream as was shown at the Syracuse convention of firemen in 1885, reaching three hundred and sixteen feet horizontally from a 1⅛ inch nozzle. Those were maximum test and tournament streams rather than for practical fire service.

VOLUMES OF HOSE JETS.

A thorough knowledge of the volume of water and rate of discharge of the fire streams to be used is a first essential in the preparation of a plan of a fire system. To illustrate the value of this we will compute and tabulate a series of serviceable streams having force to reach given heights, seventy to one hundred feet vertically, and from nozzles 1, 1⅛, 1¼, and 1⅜ inches diameters. The units, gallons, or million gallons per twenty-four hours, are of such frequent and familiar use in water supply statements and mental comparisons that the computations are stated in these terms and may consequently be easily compared with capacities of distribution pipes, stand pipe tanks and pumping machinery.

Table No. 1, covers the ordinary range of forces of jets and volumes of discharges and will indicate what provision per jet must be contemplated in the flow of the distribution pipes.

TABLE NO. 1.—DATA OF PRACTICAL FIRE STREAMS.

Vertical Height of Stream.	Diameter of Nozzle.	Pressure at the Play Pipes.	Horizontal Projections of Streams.	Gallons per Minute.	Rate in Gallons per 24 Hours.
Feet.	Inches	Pounds.	Feet.	Gallons.	Gallons.
70	1	46.5	59.5	203	292,298
70	1⅛	44.5	61.3	249	358,520
70	1¼	43.0	66.0	306	440,619
70	1⅜	41.5	67.0	368	530,149
80	1	59.0	67.0	230	331,200
80	1⅛	55.5	69.5	281	404,700
80	1¼	53.5	72.4	343	493,900
80	1⅜	51.5	74.4	410	590,400
90	1	79.0	76.6	267	384,500
90	1⅛	72.0	78.5	324	466,600
90	1¼	68.5	81.0	388	558,800
90	1⅜	65.5	82.6	468	674,000
100	1	125.	88.0	311	447,900
100	1⅛	103.	89.0	376	541,500
100	1¼	93.	92.0	460	662,500
100	1⅜	88.	92.0	540	777,700

We observe in the table, for instance, that if we use a one and one-eighth inch nozzle, a stream of 70 feet vertical force discharges at a rate of three-eighths million gallons, a stream 80 feet force discharges at a rate of four-tenths million gallons, a stream of 90 feet force discharges at the rate of seven-sixteenth million gallons, and a stream of 100 feet force discharges at the rate of nine-sixteenth million gallons, approximately, also if we use one hundred foot streams the one and one-quarter inch nozzle discharges at the rate of five-eigth million gallons and the one and three-eighths inch nozzle discharges at the rate of three-quarter million gallons, approximately.

The above jets may be from hose connected directly to the fire hydrants, or equivalent jets from steam fire engines which take their water from hydrants. The volume of the jet will be the same for the same nozzle and height of stream.

Rated capacities of steam fire engines, which is perhaps one-third greater than their ordinary rate of work at fires, are substantially as follows:

Third size	550	gallons per minute,	or rate	792,059	gals.	per 24	hours.
Second "	700	"	"	1,008,750	"	"	"
First "	900	"	"	1,296,096	"	"	"
1 (extra)	1100	"	"	1,584,118	"	"	"

In preparation of the plan of distribution there must be an estimate, with wise forethought, of the number of these strong streams, or the number of these steamers that will work at their utmost speed and draft at the same time.

FRICTION LOSSES IN HOSE.

In the above table of data of practical hose streams the volumes of water discharged per jet, 200 to 550 gallons per minute, were stated pressures at play pipe. In providing for this pressure, due allowance is to be made for friction losses in each hose according to the streams of greatest discharge which are to be used. The loss of pressure or its equivalent loss of head (h) in the hose may be found by the formula

$$h = v^2 \ (4m)\frac{l}{2gd}.$$

In this formula, as ordinarily used, for friction per 100 feet of $2\frac{1}{2}$ inch hose there are constants, viz:

$2\frac{1}{2}''$ diameter of hose d=.20832 feet and sec.=.0434 square feet, length of hose l=100 feet, and 2g=64.4, and the variables,

v=velocity in feet per second.

h=loss of head in feet per 100 feet of hose.

m=a co-efficient previously found by a series of experiments.

The velocity, v, is found from the given discharges of the jets through the given diameter of hose.

A series of these friction losses for given discharges in jets, when tabulated is a ready aid in arriving at the pressure that must be provided at any given hydrant. In table No. 2, are given friction losses in one hundred feet lengths of rubber lined smooth $2\frac{1}{2}$ inch hose.

TABLE NO. 2.—HEAD AND PRESSURE LOSSES BY FRICTION IN HOSE.

Discharge of water per minute.	Velocity of Flow per Second.	Coef. in Formula, $h=v^2 \ (4m)\frac{l}{2gd}$	Head lost in 100 feet of $2\frac{1}{2}''$ Hose.	Pressure lost per 100 feet of $2\frac{1}{2}''$ hose.	Value* of n in $v=n\,(rs)^{\frac{1}{2}}$ $n=\left(\frac{98}{m}\right)^{\frac{1}{2}}$	Rate in Gallons per 24 hours.
Gallons.	Feet.	m.	Feet.	Pounds	n.	Gallons.
200	13.072	.00450	22.89	9.93	119.6	288.000
250	16.388	.00496	35.55	15.43	120.0	360.000
300	18.858	.00441	46.80	20.31	120.9	432.000
347	21.677	.00439	61.53	26.70	121.1	499.680
350	22.873	.004395	68.48	29.73	121.2	504.000
400	26.144	.00436	88.83	38.55	121.5	576.000
450	29.408	.00434	111.80	48.52	121.8	648.000
500	32.675	.00432	137.50	59.67	122.1	720.000
520	33.982	.00431	148.40	64.40	122.12	748.800

*Values of n are deduced from the elaborate experiments on Fire Streams by John R. Freeman, C. E., given in Transactions of Am. Soc. Civ. Engrs. No. 426, Nov. 1889.)

These frictions are for given volumes of flow in the hose and the velocities respectively due to those volumes and are independent of size of nozzle. The changes in nozzles do not affect the friction in the hose if there is no change in velocity of flow, but a larger nozzle with equal pressure at the nozzle augments the discharge and velocity of flow, and and thus materially increases the friction loss in the hose.

To illustrate further the frictional effect of change of nozzles take from table No. 1, the same streams and tabulate in No. 3, their friction losses in each 100 feet of a smooth rubber lined 2½ inch hose.

TABLE No. 3.—FRICTION LOSSES FOR GIVEN STREAMS.

Stream. Height in feet.	Pressure at the Play Pipe. Pounds per square inch.	Friction per 100 ft. of Hose. Pounds per square inch.	Friction per 100 ft. of Hose. Feet Head.
1″ diam. 70 ft.	46.5	10.75	24.77
1 " 80 "	59,0	13.50	31.10
1 " 90 "	79.0	17.70	40.78
1 " 100 "	130.0	23.50	54.14
1¼ " 70 "	44.5	15.50	35.71
1¼ " 80 "	55.5	19.40	44.70
1¼ " 90 "	72.0	25.40	58.52
1¼ " 100 "	103.0	33.80	77.88
1½ " 70 "	43.0	22.75	52.42
1½ " 80 "	53.5	28.40	65.43
1½ " 90 "	68.5	35.90	82.71
1½ " 100 "	93.0	57.75	86.98
1¾ " 70 "	41.5	32.50	74.88
1¾ " 80 "	51.5	40.00	92.16
1¾ " 90 "	65.5	51.40	118.43
1¾ " 100 "	88.0	72.00	165.89

Loss of pressure, p, and head, h, in rubber lined smooth 2½ inch hose may be found approximately by the formulas.

$$p = \frac{lq^2}{4150\, d^5} \text{ and } h = \frac{lq^2}{1801\, d^5}$$

In which, p = pressure lost by friction, in pounds per square inch.
l = length of hose in feet.
q = gallons of water discharged per minute.
d = diameter of hose in inches = 2½ inch.
h = friction head in feet.

The coefficient would be decreased for rougher hose.

HOSE JETS COMPARED.

The problems introduced by changes of nozzles are so numerous it will be a convenience to assume a standard stream for this discussion and so compare other streams with the standard that they may be easily kept in mind.

If we assume first a standard height of eighty feet then discharges may be made from different diameters of nozzles approximately.

1 inch stream, 230 gallons per min. rate of .33 million gallons.
1¼ " " 281 " " " " " .40 " "
1½ " " 343 " " " " " .49 " "
1¾ " " 410 " " " " " .60 " "

The 1¼ inch stream with power to reach a height of eighty feet is a good standard for a small city or the suburbs of a large city, and this discharges water at a rate of, approximately, four tenths million gallons per twenty-four hours, a quantity easily remembered or multiplied for comparisons.

The loss of pressure and head for this standard stream is, in each 100 feet of 2½ hose, approximately 20 pounds or 45 feet net, or say including friction in the hydrant one-half (.5) foot loss of head for each foot of hose, another quantity easily remembered or multiplied.

If we change the nozzles to 1½ or 1¾ inch diameters then for the same eighty foot height of stream we increase the friction losses in the hose to approximately two-thirds foot, and one foot head respectively for each foot length of hose.

These computations show the great difficulty of maintaining a high stream through the large nozzles unless the hose is very short, especially for a gravity or direct pressure system.

Our standard single 1¼″ stream requires approximately fifty-six pounds pressure or equivalent one hundred and twenty-nine feet head at the play pipe and forty-five to fifty feet head for each 100 feet length of smooth 2½ inch hose, so that for 100, 200 and 300 feet of hose we must have available heads at the hydrant or fire engine of 174, 219 and 264 feet respectively. If we substitute 1½ inch nozzles for same height of stream we must have available heads at the hydrants or engine 195, 261 and 327 feet respectively, or we must increase the diameter of a portion at least of the long hose and save friction loss of head.

Large streams from portable water towers are most servicable when the streams are supplied by one or more steam fire engines capable of maintaining a good pressure at the elevated nozzle. The discharges, for given pressures at the nozzle are substantially as follows :

Table No. 4.—volumes of portable tower streams.

Pressure at Nozzle.	Diameter of Nozzle	Gallons per Minute.	Gallons per 24 Hours.
Pounds.	Inches.	Gallons.	Gallons.
40	1¼	433	623,820
40	1¾	563	810,847
40	2	735	1,058,444
40	2½	1,158	1,696,970
50	1¼	463	666,060
50	1¾	630	906,553
50	2	822	1,184,057
50	2½	1,285	1,850,234
60	1¼	507	729,544
60	1¾	674	970,487
60	2	901	1,297,032
60	2½	1,407	2,026,854

NUMBER OF HOSE JETS REQUIRED.

Thus far the volume and friction of one good fire stream only have been considered. Now certain numbers of these four-tenth million gallon streams must be assumed for computations of friction losses in the main and distribution pipes of water supply systems of different magnitudes.

We will assume the judicious provision of 80 foot fire streams for the ordinary fire service of cities having the populations named to be substantially as follows :

Pop. 4,000 to	10,000,	Str'ms	7 to 10.	Rates	3.83 to	5.48	Mill. Gals.
" 10,000 to	50,000,	"	10 to 14.	"	5.48 to	7.68	" "
" 50,000 to	100,000,	"	14 to 18.	"	7.68 to	9.87	" "
" 100,000 to	150,000,	"	18 to 23.	"	9.87 to	12.62	" "

COMBINED FIRE SERVICE AND DOMESTIC DRAFT OF WATER.

In American cities, populations of 4,000 use for ordinary domestic purposes about .2 million gallons daily, populations of 10,000 use .6 mill. gals., populations of 50,000 use 4.4 mill. gals., population of 100,000 use 10. mill. gals., &c.; the rate per capita increasing with the total population, and being here stated as mean daily consumption for each year.

We have for these assumed cases, combined mean rates of 4.04 6.08 12.08, and 19.87 million gallons respectively per twenty-four hours as the flow in the supply mains when a fire is in progress at mid-day.

The domestic draft of water will be greater in volume in certain hours of the day, and at certain seasons of the year.

The drafts for fire service in principal mains of the village system will be ten times the draft for domestic use, and may be always in excess until the city has a population of 80,000 to 100,000.

The excess of draft for fire service continues in the suburbs and subdistricts of cities and must be provided for in the sub-mains and distribution pipes, not less than seven standard streams in the suburbs and increasing to ten and twelve streams as the manufacturing or commercial centres are approached and the full force of eighteen, twenty or thirty streams in the centres of industries, trade and shipping, according to their values and importance.

FRICTION IN DISTRIBUTION PIPES.

From lessons of experience a maximum advisable velocity (v) of flow or as better termed for our present purpose, a maximum advisable loss of head (h) by friction in pipes of different diameters is assumed to be as follows, using as before the formula :

$$h = \frac{4lmv^2}{2gd}$$ and d being taken in feet.

TABLE No. 5.

Diameter.	Velocity of Flow.	Coefficient.	Friction in 1000 Ft. of Length of Pipe.	Friction per Mile.	Rate of Flow per Minute.	Rate of Flow per 24 Hours.
Inches	Ft p'r sec	m	H'd in Ft	H'd in Ft	Gallons.	Gallons.
4	3.10	.00647	11.59	61.195	121.849	174.859.
6	3.9	.00608	11.49	60.667	343.675	494.892.
8	4.5	.00575	10 83	57.182	704.84	1,014,970.
10	5.	.00556	10.36	54.701	1,223.88	1,762,384.
12	5.5	.00536	10.07	53.169	1,938.66	2,791,701.
14	5.8	.00520	9.33	48.246	2,782.65	4,007,016.
16	6.	.00507	9.07	47.884	3,761.84	5,417,052.
18	6.25	.00494	7.99	41.187	4,956.643	7,127,266.
20	6.5	.00476	7.5	39.600	6,362.41	9,161,875.
24	6.75	.00454	6.42	33.918	9,518.37	13,706,460.
27	6.90	.00440	5.78	30.534	12,312.56	17,689,951.
30	7.	.00425	5.17	27.318	15,422.114	22,207,845.

It may be remarked that these maximum losses of head can rarely be allowed when computing for the portions of gravity or direct pressure systems distant from the origin of the head or pressure when the hose for fire streams are to be attached directly to fire hydrants without the intervention of steam fire engines. The alternative is then to take a pipe of larger diameter.

When steam fire engines are used an allowance must be made in computing frictions for maintaining at least one hundred feet of head in the dense residence sections to provide the necessary domestic pressure in the chamber bath rooms and sanitary tanks.

PROPORTIONING DISTRIBUTION PIPES.

In computing for the fire service we find it advisable to begin with the hose stream in the air, and work backward through the nozzle, hose, hydrant and branch pipe into the distribution, so in computing for the pipe system we should begin with the distribution in each of the small sub-divisions and compute the volume of the fire service there according to the surroundings and then the local, domestic, commercial, industrial, mechanical and ornamental drafts of water, allowing for growth of the local sections, then summing the volumes of these local sections in the sub-mains and then altogether in the principal mains, and through this course we reach the maximum rate of flow from the pumping machinery of the direct pressure system, or from the reservoir or tank stand pipes.

To find the capacities of the several distribution pipes to supply fire streams alone, divide column seven, of rate of flow in above table of maximum allowable frictions by .4, million gallons the assumed rate of flow, in million gallons, for one stream and we have

Diameter of Pipe,	6″	8″	10″	12″	14″	16″	18″	20″	24″	27″	30″.
Number of Streams,	1	2	4	7	10	13	18	23	35	44	55.

The domestic and other drafts must be allowed for in the final determination of diameter of pipe. These numbers of streams are stated for pipes which receive their water from one end only, but if the flow comes

freely from both ends of the pipe toward hydrants on the same section then the capacity of the pipe is doubled and the number of hydrants on the same section may be doubled. If we compare a given flow from one end of a pipe to an outlet at its centre, with the same total flow from both ends to the outlet we find the loss of head in the second case to be one-fourth the loss in the first case.

This matter of double flow toward fire hydrants is of significant importance in the fire service system and is a strong argument against many of the dead ends, which might be made contributors of flow to hydrants.

FRICTION HEADS FOR GIVEN NUMBER OF STREAMS.

The friction losses for the given number of streams are to be summed, beginning with the hydrant branches, then in the distribution pipes which supply them, then in the sub-mains, and then in the principal main, back to the pumping machinery, or reservoir.

Such frictions are tabulated for pipes of different diameters, in table No. 6, and are for a flow in one direction. The volumes may apply to combined streams or to equal combined streams and domestic drafts.

TABLE NO. 6.—HEAD LOST BY FRICTIONS IN SMOOTH PIPES, IN EACH 1,000 FEET LENGTH.

Friction Heads for given Diameters of pipes and Numbers of Streams

No. of str'ms of .4 mil. gals each.	Total discharge in Mil. Gals.	6″	8″	10″	12″	14″	16″	18″	20″
		Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.
1	.4	7.8	1.85	0.62	0.24	0.12	0.05		
2	.8	27.0	6.90	2.30	0.92	0.43	0.22		
3	1.2		15.10	5.00	2.00	0.93	0.48	0.27	0.13
4	1.6			8.70	3.50	1.64	0.84	0.53	0.25
5	2.0			12.17	5.32	2.47	1.24	0.78	0.40
6	2.4				7.60	3.49	1.77	1.06	0.58
7	2.8				10.20	4.70	2.38	1.37	0.77
8	3.2				13.05	6.06	3.07	1.74	0.97
9	3.6					7.60	3.87	2.14	1.24
10	4.0					9.30	4.77	2.63	1.54
11	4.4					11.20	5.72	3.14	1.83
12	4.8					13.15	6.74	3.70	2.16
13	5.2						7.84	4.33	2.54
14	5.6						9.08	5.04	2.93
15	6.0						10.40	5 74	3.36
16	6.4						11.30	6.53	3.80
17	6.8						12.45	7.40	4.24
18	7.2							8.25	4.73
19	7.6							9.13	5.28
20	8.0							10.00	5.83
21	8.4							10.90	6.40
22	8.8							11.70	7.00
23	9.2								7.67
24	9.6								8.33
25	10.0								9.00

DIAGRAM OF FRICTION HEADS.

A diagram is presented herewith illustrating the above table, from which the friction head in each one thousand feet of pipe, of given diameters for given discharges may be taken.

The diagram will also show by inspection the frictions of the combined fire and domestic flows in the several diameters of pipes within the range of ordinary velocities of flow in public water supply systems.

HYDRANT SECTIONS.

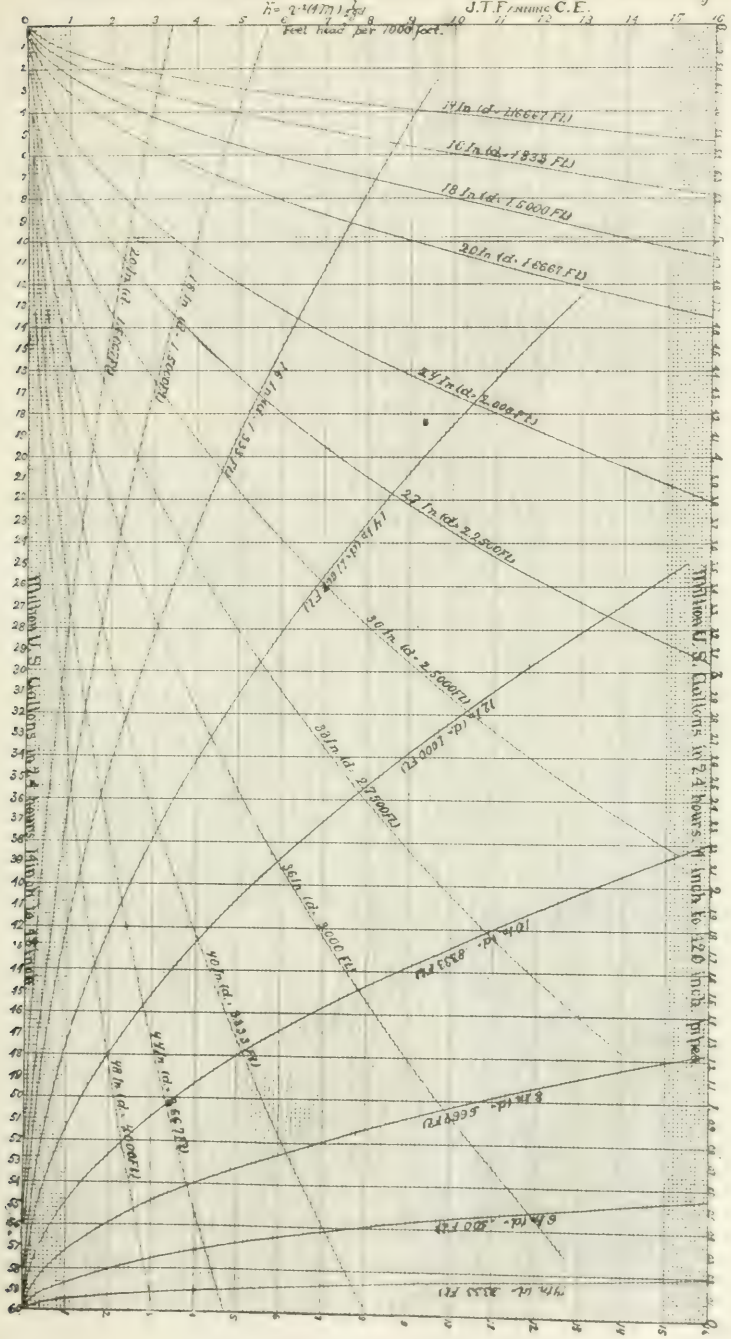
The computations already given of losses of pressure and head when relatively large volumes of water are forced through small, straight pipes and hose, have shown and emphasized the error of attempting to use mains that are too small for their legitimate work. Such a mistake is more glaring when the crooked passage through a hydrant branch and post hydrant are considered. The post hydrants and branches, as often used, consume eight or ten pounds of pressure when a single good fire stream is flowing through them, or practically as much as a fifty foot length of hose. The hydrant branch is often too small and the angles through which the stream must pass, both in leaving the main and the hydrant are too sharp.

If the main pipe ought to be eight inches in diameter to flow the water in one direction for two strong streams then the hydrant branch and barrel ought certainly to be eight inches for the same duty. They are too often mistakenly made four inches in diameter for one stream, or six inches for two streams. It is apparent that when strong streams are desirable, the object may be in part defeated by small hydrant branch and hydrant sections even though the pressure is good in the mains. The additional cost of the second nozzle on a post hydrant is small, so that when the pressure in the main admits of direct connections of leading hose to the hydrants, as in high reservoir or direct pressure systems, the advantage of the second stream may far overbalance the additional cost of the nozzle. An independent gate in the hydrant head for each nozzle is sometimes of exceeding value and worth much more than its cost.

The value of a flush hydrant located over the branch at the intersection of the street mains has been often urged for use in the dense portions of large cities because its capacity there for several streams is greatest and its friction losses least, and such hydrants have had considerable use in the eastern New England cities. Favorable results may be obtained if a large branch pipe, equivalent to the main, is taken to a hydrant with large valve and barrel, at the curb line. This is as essential for a good fire service as mains of adequate diameter.

Hydrants should also be near together so that the lines of hose may be short. The hose may have to be lengthened down alleys, or through or over one or more buildings to reach the burning building.

In the dense portions of the cities there should be a hydrant which is proportioned for at least two strong streams, at each street intersection, and in the commercial and manufacturing sections, a like hydrant at a central point between the street corners, on the principal streets. This arrangement is not less desirable for a steam fire engine service than for a direct connection hose service. The intermediate hydrants are likewise valuable on high grounds where pressures are light for direct connections.


FRICTIONAL HEAD IN MAIN AND DISTRIBUTION PIPES (in each 1000 ft length)
J.T.FANNING C.E.
Feet Head per 1000 feet.
Million U.S. Gallons in 24 hours, 1 inch to 120 inch pipes
Million U.S. Gallons in 24 hours, 1 inch to 120 inch pipes

ASSISTANCE OF NEIGHBORING FIRE DEPARTMENTS.

Nearly every large city whose pipe system has been inadequate can cite its own experience when its entire fire department could not cope with a fire that had a good start and the fire departments of neighboring cities came to the rescue with steamers and hose carriages. Chief Damrell testified before the commission that investigated the Boston Great Fire in 1872, that he telegraphed for asssistance to every town and city within fifty miles of Boston. There was a hearty response with between forty and fifty steam fire engines, but the water mains and fire hydrants proved inadequate, and also the diversity in threads on hydrant nozzles and hose couplings was a source of delay and disappointment.

PRECAUTIONS.

In citing above, ten strong streams in the suburbs and eighteen or twenty strong streams concentrated in the business centres of cities as requirements for the ordinary fire service of single fires, these were not intended to present maximum requirements or to cover two or three large fires at the same time. During a recent fire at a grain elevator in Minneapolis the intensely hot air carried masses of large burning cinders high in the air and they were scattered, not only among frame cottages and outbuildings of wood within half a mile to windward, but also over wood-yards and lumber yards until all the fire hydrants in a large area were in use.

At the American Print Works fire in Fall River in 1874, there were forty hydrants in use. At a Providence fire, in 1877, there were at the same time in use seventeen streams direct from the hydrants, and eight streams from steamers, estimated to have been using about 4,500 gallons of water per minute, or a delivery equivalent to sixteen of our standard streams. At the Bedford Street fire in Boston in 1889, there were reported twenty-five hydrants in use supplying fifty-two steamers delivering eighty hose streams. The maximum consumption of water by hose streams was estimated twenty thousand gallons per minute or at a rate of 28,800,000 gallons per twenty-four hours. The estimated total quantity used on the fire during the first twenty-four hours was fourteen million gallons. At the recent Seigel-Cooper fire in Chicago there was reported twenty-five steam fire engines in use.

Superintendent Darling of Pawtucket has told us that at the burning of a lumber yard in his city, he had fifty-two hose streams in use at the same time, and the use of so many streams prevented a conflagation that was liable to have destroyed a million dollars worth of property.

RELATIVE COSTS AND CAPACITIES OF MAINS.

The capacities of water mains increase relatively faster than their costs. For instance let us assume the cost of cast iron pipes adapted to 100 pounds per square inch pressure to be $30.00 per net ton delivered at the trench. Then in a suburb where the streets are not paved the costs of the pipes laid complete, and delivery capacities of the pipes, on the velocity of flow and frictional bases above stated, will be substantially as follows, if we state capacities in million gallons per twenty-four hours as the unit.

TABLE No. 7.—RELATIVE COSTS AND CAPACITIES OF PIPES.

Diam. of pipe, inches.	6"	8"	10"	12"	14"	16"	18"	20"	24"	27"	30"
Cost Laid, - - -	$0.79	$1.07	$1.40	$1.75	$2.16	$2.64	$3.10	$3.63	$4.95	$5.79	$6.82
Capacities, Mill. Gals.	0.593	.978	1.748	2.792	4.003	5.339	7.138	1.168	13.912	17.731	22.305
" No. of Hose Str's	1.	2.	4.	7.	10	13	18	23	35	44	55

In changing a pipe from an eight inch to a ten inch diameter we increase the cost thirty per cent and the capacity seventy-nine per cent. If we change a pipe from ten to twelve inch diameter the cost increases twenty-five and the capacity sixty per cent, and so in larger diameters, if we change the pipe from a twenty to a twenty-four inch we increase the cost thirty-six and the capacity fifty-two per cent.

DUPLICATE FLOW.

In considering an orifice or jet at the centre of a long pipe, say in a suburban street, we found that if the flow could come with equal advantage from two directions a jet might be duplicated without greater loss of pressure than when the flow came from one direction only, and also that by giving flow from two directions to one jet and thus reducing the velocity one half, the loss of pressure was only one-fourth that due to the single flow. Here is a suggestion to be kept constantly in view in planning a new system and in the extension of an old system of pipes. It not only gives double capacity to the combined fire and domestic service, or saves three-fourths of friction head, but it gives two channels of supply to every point so that if in case of extensions or repairs one line is shut off another line is still open and the domestic and fire service maintained. Neither fire or domestic service should be subject to the contingency of one line of supply main only.

The original plan of pipes and plans of extensions in growing cities, also must anticipate the increase of capacity of mains inevitably necessary, and foresee where a larger reinforcing pipe will best be placed when it is needed, and its relation to the entire system.

The duplicate flow advantage applies as well to the hose as to the distribution pipe. If the jet is far from the hydrant and the friction loss excessive the loss of head is at once reduced three-fourths by duplicating the hose from hydrant to play pipe, or loss of pressure may be greatly reduced by using hose of greater diameter so far as it can lie on the ground or have support other than by hand.

The increasing domestic draft of water in growing cities often leads to such increased frictions in the mains that their value for fire services is much reduced also. For instance the fountain in New York's City Hall Park used to throw its large jet sixty feet high, and the water would flow into the highest stories of the down town buildings with ample force, while now the head from the reservoir is almost entirely consumed by frictions in the distribution pipes. The proper remedy in such cases is to make the mains adequate for their legitimate duty. In many cases a tank standpipe on the side of the distribution opposite to the reservoir or pumps is a valuable aid both in supplying water and reducing friction from the main supply. Such an elevated tank holding one-half million gallons of water will alone supply ten 1¼ inch, eighty foot streams, from three to four hours.

The objection may be anticipated that the ten suburban streams or twenty urban streams above mentioned as serving for ordinary fires are entirely inadequate for great emergencies, and that such fires as those originating in the grain elevator and lumber yard above mentioned will be cited. The first answer must be, that the ordinary fire service is not, and usually for financial reasons cannot be proportioned to conquer great conflagrations. Its prime object is to control and then stop a fire in its early stage, and it must be the most adequate and effective service for this duty which the circumstances will permit, and re-enforced with all electrical and mechanical aids that science offers, so that knowledge of the fire may be given early and attack on the fire may be prompt, energetic, and successful.

Let us consider further what may be done with, say ten good streams. The standard selected for this discussion is a 1¼ inch diameter stream, with force to reach a vertical height of eighty feet, and the mains proportioned so that the required number of streams may be given with flow in one direction, equivalent single flow, in the distribution pipes. If the fire is already hot, then a few heavy streams will be most effective and there may be used eight 1¼ inch or seven 1⅜ inch streams which will take nearly equal total volumes of water and have equal forces of jets.

If a scattering suburban fire requires more than ten 1¼ inch streams, we may put their equivalent total discharge of water into one inch diameter streams as follows :

14 streams of 70 feet height.
16 " " 60 " "
18 " " 50 " "
20 " " 40 " "
24 " " 30 " "

or if the same total discharge of water is used in seven-eighth inch streams there may be,

15 streams of 80 feet height.
18 " " 70 " "
20 " " 60 " "
22 " " 50 " "
26 " " 40 " "

Then if the distribution system of mains is planned for double flow through two or more mains, as is desirable to prevent a hydrant being out of use by a shut off of one of its approaches, the numbers of hydrant streams named above may be doubled or the fire may be fought with 1¼ or 1½ inch streams by doubling, or the use of enlarged hose, or the upper story of a warehouse may be flooded by a portable water tower with a 1½ inch stream, and still there will be water and pressure for a number of ⅞ inch streams available to put out the incipient blazes to the windward among low buildings.

A hot fire must be attacked with streams of large volumes of water that strike with force, for puny streams are but converted into vapor before they pass through the heart of the flame. Large and strong streams are best ensured from near hydrants, and through short hose.

An increased number of hydrants is often cheaper than increased

power at the pumping station or an increased elevation of the reservoir, and is always cheaper and more effective than long fire hose.

COMBINED DOMESTIC AND FIRE FLOWS.

The conditions of fire risks in different cities, even of equal populations, are so unlike, that rigid rules are not generally applicable as to the proper volume of flow in the mains for fire services. The variableness may be magnified when the combined fire and domestic rates of flow are considered. In a majority of the cities the influences governing flow for both services are nearly similar, and in those we may assume for a general computation that the principal mains leading out from the reservoir or from direct pressure pumps will be proportioned for rates of flow to given populations substantially as in the following table, when hose streams are taken direct from the hydrants. A study of the local conditions of a given city will show when its pipe flow will not approximate closely to the table and will readily suggest the degree of variation therefrom.

TABLE NO. 8.—COMBINED RATE OF FIRE SERVICE AND DOMESTIC FLOW. (DIRECT PRESSURE SYSTEM.)

Population	Rate of Flow for Fire Service.	Number of Fire Streams	Mean Rate of Flow for Domestic Service.	Combined Rte of Fire & Domestic Flow.	Diameter of a single Main.
	Mill. Gals.		Mill. Gals.	Mill. Gals.	Inch.
4,000	3.9	7	.20	4.10	14
5,000	4.10	8	.25	4.35	16
6,000	4.30	8	.30	4.60	16
8,000	4.65	9	.45	5.10	16
10,000	4.90	9	.60	5.50	18
15,000	5.50	10	1.00	6.50	18
20,000	5.90	11	1.40	7.30	20
25,000	6.25	12	1.90	8.15	20
30,000	6.50	12	2.40	8.90	24
40,000	7.10	13	3.40	10.50	24
50,000	7.50	14	4.40	11.90	24
60,000	8.00	15	5.40	13.40	27
75,000	8.75	16	7.10	15.85	27
100,000	10.00	18	10.00	20.00	30
125,000	11.25	21	13.10	24.35	33
150,000	12.40	23	16.00	28.40	36
175,000	13.50	25	19.00	32.50	36
200,000	14.50	27	22.00	36.50	30 & 27
250,000	16.60	30	28.00	44.60	33 & 30
300,000	18.30	34	34.00	52.30	33 & 33

It is to be remembered that in many cities the domestic draft of water is quite variable, therefore when the principal mains are proportioned for mean daily rates of flow, as computed in table No. 8, there will be some lack of strength in the respective given number of hose

streams at such times of day, or season as the domestic draft is in excess of the mean daily rate for the year.

In the last table, the computation per capita is assumed to gradually increase from 66⅔ gallons daily when the population is 15,000, to 120 gallons daily when the population is 250,000.

When steam fire engines are used to take the water from the hydrants a temporary drop in the domestic pressure may be admissable during the brief period in which the fire is being conquered. Frequently, in connection with the steam fire engine hose service the domestic consumption may be treated in the computation as though uniformly 66⅔ gallons per capita for all populations.

The combined domestic and fire rates of flow and relative dimensions of mains will then compute as in the following table.

TABLE No. 9.—COMBINED RATE OF FIRE SERVICE AND DOMESTIC FLOW.

(STEAM FIRE ENGINE SERVICE.)

Population.	Combined Rate of Fire and Domestic Flow.	Diameter of a Single Main.	Usual max. Friction Head per 1,000 feet of Pipe.	A proper max. rate of flow in the single main.	Subdivided Mains, Equivalent to the single main.
	Mill. Gals.	Inches	Feet.	Mill. Gal.	
15,000	6.500	18	6.78	6.56	Two 14″ diameter mains.
20,000	7.233	20	6.34	8.41	Two 14″ " "
25,000	7.917	20	6.34	8.41	One 16″ and one 14″
30,000	8.500	20	6.34	8.41	One 19″ and one 14″
40,000	9.767	24	5.60	12.80	Two 16″
50,000	10.833	24	5.60	12.80	One 18″ and one 16″
60,000	12.000	24	5.60	12.80	Two 18″
75,000	13.750	27	5.13	16.64	Two 18″
100,000	16.667	27	5.13	16.64	Two 20″
125,000	19.583	30	4.78	21.20	One 24″ and one 18″
150,000	22.400	30	4.78	21.20	Two 24″
175,000	25.167	33	4.48	26.40	Two 24″
200,000	27.833	33	4.48	26.40	One 27″ and one 24″
250,000	33.267	36	4.26	32.60	Two 27″
300,000	28.300	40	4.00	42.20	One 30″ and one 27″

In this last table of sub-divided mains the allowance of frictional head per thousand lineal feet of pipe is taken slightly less than the system limit stated in Table No. 5.

The frictions in large pipes are much less for given velocities of flow than in small pipes, also the coefficients of flow vary materially with change of velocity and with change of diameter. These influences are not to be overlooked in computing subdivided mains as the sub-divisions do not follow quite proportionately with the ratio of square root of the fifth power of the diameter of the pipe.

If there is in connection with the pipe system a considerable use of

hydraulic power by motors, goods hoists, and passenger elevators, or a considerable draft for ornamental, or for irrigation purposes, the extra flow must be allowed for in computing the frictions in those portions of the water mains having the extra flow.

FIRE SERVICE VERSUS FIRES.

Often the cost, relatively, of properly proportioned mains is an obstacle difficult to overcome. Often the necessity of properly proportioned mains is not sufficiently appreciated by municipal boards to receive a sufficient appropriation. Often little heed is given to an assertion, even though well supported by facts, that such an increased appropriation as is necessary to ensure a well proportioned pipe system, will for each thousand dollars additional expenditure probably save from destruction at least one hundred thousand dollars in value of property.

While no city fire service mains can be expected to control a great conflagration until it has almost burned itself out, no municipality can afford to have its service mains unequal to powerful and successful attacks on one or more fires, in their early stages.
stages.

It is the earnest hope of the writer that these few hints and suggestions will emphasize the value and necessity of carefully planned and constructed distribution pipe systems for the combined fire and domestic water service of cities and will also emphasize the value of well designed fire hydrants and stop valves that are not undue consumers of head pressures.

Careful and adequate provisions, in construction of the essential details, will lead to efficient fire systems that will fulfill the stated object for which the fire service is planned.

If this object is fulfilled in any system where there is also an efficient fire department there is little probability of a great conflagration gaining sway within the command of that system and department. A match of strength comes betimes in every city between fire and fire service, and the fire departments are hampered if the mains do not respond. Every city has to choose inevitably which is the cheaper, which is the better, a conflagration almost surely impending with dire disaster or an efficient fire service which makes the conflagration almost impossible.

Minneapolis, Minn., February, 1892.

MR. FULLER.—I feel very much obliged to Mr. Fanning for this paper, which I think is an excellent one, and upon which every member of this Association can bestow a great deal of thought and study. There are one or two points brought out in the paper which seem to me to be very important. One was the size of the hydrants and hydrant branches. I do not know how the works represented here are planned, whether they have large hydrant branches or whether they have small ones—as small, perhaps, as four inches. It seems to me this is an important consideration. I think his statement that hydrants should be placed nearer together than they are

usually put is important. I know in a great many places the authorities, the commissioners, or those who have the matter in charge, are apt to think that hydrants can be placed a long distance apart, anywhere from five hundred to a thousand feet. After considering the facts which Mr. Fanning has presented, I think we can safely say that hydrants ought to be placed much nearer together to give the best results, say 300 feet apart in the closely-built portion of a town and 400 feet apart where not compactly built. Of course, if the number of hydrants is increased the length of hose is necessarily decreased, and the head required to do effective work can also be reduced; so that, as he has expressed it in his paper, the elevation of a reservoir can be somewhat lower, which, of course, oftentimes means a decrease in the first cost. There are a great many things to be considered in planning a system, and planning it economically. Oftentimes an additional number of hydrants, or an increase in the size of main and hydrant branches will lessen the expense somewhere else; and perhaps in the end the economy and efficiency may be greater. Where only a moderate elevation can be had for a reservoir, larger pipes and more hydrants must be used, so that the pressure may not be wasted by loss from friction in small mains and long lengths of hose.

Mr. Wanner.—I consider the paper just read a most valuable one. Its precepts, in my opinion, will apply to most of the cities and towns of the country. We learn most of our necessities or wants by experience. It is pretty well known that the city of Reading, from which I come, is a growing town. It has also been well known to underwriters that for a number of years its service mains have been too small; or, in other words, that the city had outgrown the mains and service pipe of twenty years ago. We have had a number of fires within the last few years that could have been prevented if we had had pipes sufficiently large to cope with them. Now it would seem very strange that the people should hang back in emergencies and necessities of this kind; but they will do it. It was only through the agency of these fires that the necessity of an enlarged and improved service was driven home to our people. The best men in the town got together and agitated the matter and finally pro-

duced a remedy, and that is in laying large mains from north to south and connecting them with small ones east and west. This system will be completed before the end of the season and will give an efficient service for years to come. Prior to this the pipe service there could be likened to the trunk of a tree and the laterals to its branches. They kept on adding to the laterals until the branches were out of all proportion to the trunk. In case of a fire there was no way of extinguishing it ; and it was a pitiable sight. It was disgraceful, it was criminal—to see fires raging, destroying properties, with no adequate remedy. If Providence had had no more care for the citizens than they for themselves, the city would have been destroyed more than once. This was especially true on two occasions, when, if the weather had been dry or sufficient air had been stirring, such as we have had lately, the flames would have swept the town. To think that we should have had two or three fires, and with the loss on either of them larger than the cost of these additional improvements, is simply staggering ; and I have no doubt that there are hundreds of cities and towns throughout the country precisely in the same condition. Is not that the poorest kind of economy ? For that reason I think this paper is exceedingly opportune. I believe it will apply to the greater portion of our water works systems throughout the land. People are too economical—in other words, too stingy, or, to make it even plainer, too mean, in the matter of water works, whether owned by the city or by private parties. There is nothing like an abundant water supply and large mains to distribute it, and it is well to have plenty of fire hydrants, so as to afford every facility for the extinguishing of fires. We have quite an efficient department at Reading; but at the fires referred to the services of not more than one-third of the department could be brought into play, for the want of water. It was disgraceful, and yet I have no doubt that there are many here who represent cities which are in the same condition. Reading will be well provided before the end of the season, and there is no reason why other towns should not be fixed in the same way. In the end it is the best economy and is what should be done by every city and town that has a water service for fire protection.

MR. MATHER—Mr. President.—This is a very able paper, and I am pleased that it has been read before this Association. In order to have complete fire protection there should be an abundant water supply, large mains, good pressure and a sufficient number of well constructed fire hydrants. The fire hydrant does not cost as much in place as one length of hose of fifty feet, and its life is hard to determine. We have quite a number that have been in use for forty years and they are still doing good service. A length of hose may last ten or fifteen years and it may not, much will depend on the care and attention it receives. If this Association could lay down some general rule, formulated from the experience and observation of its members conversant with the subject, giving the number of fire hydrants per mile of mains, or per area, or per capita, that would be advisable to place as a minimum, some good might result, and I think would. Of course this Association can merely be suggestive in its action.

But suggestions of this sort may be acted on by the members in their respective plants, intelligently. The number of hydrants per mile or per capita in one town sufficient to give good protection might be inadequate in another; so that, like many other questions we have to deal with in the management of a water department, fire protection to be reliable and effective, must depend on good judgment, always going in the direction of enough hydrants. In the city of Harrisburg we have upwards of 500 fire hydrants and thirty-five miles of mains. But of these mains upwards of two miles are force and return mains, on which there are no hydrants. So that we have an average of about fifteen to the mile. By reference to the accompanying table it will be seen that we are well provided, in fact have double the average given for the United States.

Perhaps this may have something to do with the small fire losses in our city for many years past. If we find that any part of the city has been built up so as to need better fire protection, we at once place additional hydrants. In this way we have added upwards of twenty the past year to old mains. We have a tapping machine and don't shut off the water when making the six-inch attachment which we always use. I may add here, that

all our fire hydrants, no matter where placed, have a steamer and two hose openings. We have purchased no other kind for several years, and think these the best. My attention was especially called to this question of fire protection by reading in the Philadelphia papers that the rates for fire insurance in that city were about to be raised. Thinking it might reach our people, I felt curious to know on what basis the underwriters fixed their rates in the respective cities. On inquiry I could not get what I regarded as a satisfactory answer. It naturally occurred to me that the rates for fire insurance should depend largely on the character of the water supply, pressure, number and condition of fire hydrants, either per mile of mains or per capita protected. I compiled a table of both, for all the towns of Pennsylvania above 10,000 inhabitants. This showed that Harrisburg had more hydrants per mile and per capita, better general pressure and supply than any other city in the state. I submitted this table to our local Board of Fire Underwriters. There was no addition to the ratio here. I did not inquire about other places. Thinking it might serve the purpose of getting the members of this body interested I compiled a table covering the United States. The ratio in this may be raised if the length of supply and force mains can be learned, but even then it is far too low for that fire protection which is to arrest these $10,000,000 going up annually in smoke.

*FIRE HYDRANTS PER CAPITA AND PER MILE OF STREET MAINS IN THE UNITED STATES IN 1891.

STATE.	Per Capita.	Per Mile.	STATE.	Per Capita.	Per Mile.
Maine	120	3.7	Michigan	90	7.3
New Hampshire	90	5.8	Illinois	91	8.9
Vermont	87	3.2	Wisconsin	83	8.8
Massachusetts	73	7.1	Iowa	100	8.5
Rhode Island	77	6.8	Minnesota	84	9.7
Connecticut	97	6.	Kansas	72	9.
New York	118	8.5	Nebraska	101	7.8
New Jersey	100	7.	S. Dakota	71	6.3
Pennsylvania	121	6.	N. Dakota	86	7.
Delaware	93	7.9	Wyoming	110	2.6
Maryland	206	4.3	Montana	82	4.3
District of Columbia	213	5.	Missouri	113	8.6
Virginia	141	4.9	Arkansas	113	6.
West Virginia	102	6.3	Texas	132	4.3
North Carolina	100	7.6	Colorado	61	5.
South Carolina	109	9.8	New Mexico	106	3.1
Georgia	110	8.2	Washington	158	3.6
Florida	70	8.6	Oregon	127	3.
Alabama	80	5.7	California	134	3.
Mississippi	97	8.	Arizona	35	6.8
Louisiana	188	14.	Nevada	72	2.4
Tennessee	150	5.8	Utah	193	3.2
Kentucky	128	6.3	Idaho	61	5.6
Ohio	111	5.2			
Indiana	87	11.			
Average in the U. S. for 30,000 miles of mains				103	6.78

MR. LINNEEN.—I have listened with some interest to the table read by the gentleman who last spoke, and the conclusions that he has furnished are these: that a great many States use less water than others. I know this is particularly true as regards Louisiana and Kentucky. There is very little water used in those States. They do not require so many hydrants in New Orleans as in New York. They take it "straight" (Laughter.) It is pretty hard for this Association to fix a rule or standard in regard to any such matters. The difference in the size of mains, the difference in the size of hy-

*Copied and tabulated from "The Manual of American Water Works," 1890–91, *Engineering News*.

drants, the amount of water required by the population, etc., all enter into the calculation. It cannot be done. It is a matter that, in my opinion must be relegated to the different municipalities of the country, who can bring to the solution of the problem the best ability that they can command, locally or otherwise. I think it is a matter that this Association cannot take hold of with any success. Circumstances alter cases. In the case of Reading, a statement concerning which I have just listened to, I should judge that the conditions there were very favorable. In public expenditures, it is very difficult to meet the wishes of the tax-payers. If you take a liberal common council, that contemplates the requirements of a growing city, and are willing to engage in matters that will insure the safety of property in the distribution of water mains of adequate size and which will furnish an adequate amount of water in case of necessity. If you elect a common council, or board of water commissioners, imbued with a spirit of liberality and a knowledge of the requirements of a place, and who have the courage to provide for these requirements, in a year or two the tax-payers will relegate them to obscurity; they have no use for them. They are branded as "boodlers," robbing the tax-payers; and it is only the occasional visitation of the hand of Providence that a great many stingy cities in this country are awakened to the necessity of progress and the procurement of proper fire protection. This Association, in my opinion, can grasp that subject and discuss it intelligently; and whatever may be said about the necessity of procuring adequate water supply for these cities, could be published in our reports, and in this way might have some effect upon the community.

Mr. Rider.—I would like to ask Mr. Mather if in compiling his statistics he took into consideration the length of the mains.

Mr. Mather.—I simply give the data as I found it in the publications.

Mr. Nichols.—A matter has been called my attention recently which may be of some interest to the members of the Association. In the city of Cleveland it is

proposed to put in each street, running from the lake a line of mains, beginning with ten inches in diameter, and reducing to eight and six inches, furnished with a special hydrant, with no valve, except at the nozzle; and these are to be furnished with three and one-half inch hose, so that they can use a two-inch discharge nozzle. The object is that when a fire starts, they will run the fire boat to the streets nearest to the fire, and they can put on a pressure of 200 to 250 pounds, and give them an excellent fire protection on the hill which they cannot get from their ordinary service. As soon as the fire is over, and there is no more use for the water in the pipe, the water can be drawn back to the harbor. I merely speak of this as I think it might be of benefit to some other places.

MR. BRUSH.—This is a very interesting suggestion of the gentleman, and I would like to ask one or two questions. It is somewhat of a novelty in the method of fire protection, although it has been discussed and referred to a number of times. I did not know before that it had been put in operation. As I understand it is now in operation in Cleveland.

MR. NICHOLS.—No, sir. It is not in operation, but it will be during the present season. The nozzles will be for three and one-half inch hose. The hydrant was made specially for that purpose, and there is no valve in the hydrant, except at the nozzle. These are left open, but the cap is screwed on very tightly, so that in coming up, they can just merely shut down the nozzle. After the fire is over the water can be drawn off very easily. They can put on 200 or 250 pounds pressure, which gives them a chance to put out an ordinary fire.

MR. BRUSH.—I would like to ask several questions. Do I understand the proposition is, that when the fire is over, the water is drawn off?

MR. NICHOLS.—Yes, sir.

MR. BRUSH.—Then how long will it take to fill the pipes before they are in condition for use?

MR. NICHOLS.—I cannot say.

MR. BRUSH.—I merely ask the question because it seemed to me that the value of a fire protection is its immediate availability. If mains of that size have to be filled, and have to be filled to such considerable pressure as is proposed, it seems to me the city will burn down before they are filled.

MR. NICHOLS.—These pipes will only be about a foot and a half or two feet under the pavement, and they have to be drained out in cold weather. As I understand, they keep them empty all the time except during the fire service. I do not know as to how long it takes to fill them. The distance is about one-half or three-quarters of a mile; each street having a separate line for itself. There is no connection between the different streets.

MR. BRUSH.—How many miles of pipe is it proposed to lay?

MR. NICHOLS.—I cannot say.

MR. BRUSH.—Four or five miles anyway?

MR. NICHOLS.—Probably two or two and one-half miles.

MR. BRUSH.—It would probably develope into five or ten miles.

MR. NICHOLS.—Yes, sir, they intend to add to the construction every year.

MR. BRUSH.—It is intended to supply all from one station?

MR. NICHOLS.—The supply is from a boat, that is, a boat runs along the front of the harbor. When a fire breaks out, of course the men on the boat know it as soon as anybody else. The boat will be connected to the line and will pump into that only. Each street has a separate line of pipes for itself, and it is not required to fill a very large system. It ought not to take over five minutes, or ten minutes at the most, to get up a full pressure in any of these pipes, because the point of delivery is not distant.

Mr. Brush.—The subject is unique and interesting, and I have asked these questions to bring out the matter for the benefit of the members of the Association. It certainly is interesting; and if the gentleman, or some other gentleman, would give us a description of just what is to be done, and if it is done, how it works, it would be an interesting contribution to the records of the Association.

Mr. Nichols.—The Assistant Superintendent has charge of that work and I will state to him that the members of this Association would like a description of the system; and I will request him to write a technical article for publication.

Mr. Linneen.—Just one word further on this matter. I do not propose to criticise the gentleman, nor do I undertake to criticise the scheme outlined by the gentleman. It seems to me, however, that to practical minds it is not a feasible plan and I will state my reasons. It seems that lines of mains are to be laid in streets terminating at the lake, and are to run up a mile and a half, and hydrants are to be set on these lines of pipe, without any valves; the pipes being eight to ten inches in diameter. They are to depend upon fire boats to pump the water through these pipes. The boat may be near at hand, or it may be a mile away. I have examined a great many fire boats on the lakes. We have put machinery in these boats, and I have not yet seen a pump in a fire boat large enough to force a stream through an eight-inch line of main. There is another objection which I do not think can be overcome. The boat comes along with its hose, and they have got to make a connection from the pump with the pipe before they can pump. They have got to pump sometime before they can get the air out of the pipe. I do not think that is practicable or feasible, and I do not think it is worth any further discussion or consideration.

Mr. Rider.—I would like to ask how they are going to handle it in the winter months. The boats may be tied up and the lake frozen solid. Through the winter months it would be entirely useless; it might do very well for summer.

MR. NICHOLS. As I understand this matter, it is merely for additional fire protection. They have an excellent fire service in the city, and this is merely for additional protection. Of course, there are difficulties, as Mr. Linneen has suggested in making these connections. Whether it will pay is something I am not prepared to to say. They will give the public the benefit of their experience.

MR. MCELROY.—I think a practical illustration on that subject is worth a good deal of theory. We had the misfortune to have a break in our aqueduct in Brooklyn a few months ago through the carelessness of the contractor. It destroyed the entire supply of the city for two or three days, and we had the misfortune of having a very bad fire in the lower part of the city. The only salvation of that portion of the city at that time was the fact that we had the fire boat and the connection of hose which enabled us to reach the fire. That is a practical fact, and I think it settles the question of the wisdom of the people of Cleveland.

MR. LINNEEN.—There is no question about the practicability of fire boats. That is a settled fact in all cities bordering on rivers or lakes, but what I claim to be impracticable in the application of fire protection by boats, is to undertake to pump into the mains on the streets from the machinery on the boat. Now the pumps on a fire boat are ready to respond to the service, but they carry their own lines of hose, and the moment the boat reaches the dock, the pressure is on, and they are ready to throw water on the fire. But to stop to connect these pumps with a system of pipes running up a street or avenue is quite another thing and I do not think it is practicable.

MR. GARDNER.—Speaking of fire protection by means of fire boats, reminds me that there is a proposition in New Orleans to protect our river front by this means, but we have this advantage in our favor—We have a fall from the river front, three miles back of about fifteen feet. It is proposed there to have a powerful boat throw the water over the levee and allow it to run down the gutters, so that the engines can take

the water from the gutters as it comes down. I think that is better where the fall is sufficient to give rapid delivery of water to the engine.

Mr. Rider.—Where the thermometer does not get below zero half of the year.

Mr. Gardner.—It is unfortunate for those people who live in the places where it does.

Mr. Dunham.—It seems to me wrong to talk about doing the work effectively at all seasons of the year from the lake; but the river which winds through the city is open the greater portion of the year, so that this boat can be moved about, probably ten months in the year, and some winters, all winter. They take pains to keep the river open, and I think pipe connections could be made so that the boat could reach them and deliver its water.

The President.—From what I know of the river, it would rather add to the fire. Is it not pretty oily?

Mr. Dunham.—It has been. One thing in Mr. Fanning's able paper may have been partially overlooked in the discussion. He refers to the fact that there is the widest difference in the requirements of a fire protection in the different towns; and it seems to me evident that it is impossible to fix any rule that shall introduce no other factor than the population; for there are towns in which a bucket brigade would be more effective in preventing losses from fires than the city fire protection, as he has outlined it, would in other towns of the same population.

The President.—This is one of the most able papers that we have had, and it is going to add greatly to the value of our reports. I think Mr. Fanning deserves the thanks of the Association.

Mr. Espy.—I move the reception of this paper, and that a vote of thanks be tendered to Col. Fanning for the paper.

Motion carried.

THE PRESIDENT.—With your permission we will proceed to the reading of the next paper "The Kansas City Case," by Major B. F. Jones.

Major Jones read his paper as follows :

THE KANSAS CITY CASE.

BY B. F. JONES.

In the following pages I will endeavor to describe, as briefly as possible, "The Kansas City Case," giving some historical facts stretching over a considerable period of time. While it may be a trial to the patience of some, still, in view of the situation affecting, more or less, every private institution of its kind in the country, it may be of some service.

In 1873 a contract was made between the city of Kansas City Mo., and the National Water Works Company, of New York, wherein the company was granted the usual rights to furnish the city and its inhabitants with water for a term of twenty years, the city reserving to itself the right to purchase the works with all extensions and enlargements thereof, *at any time*, at a fair and equitable valuation, and limiting the bonded debt of the company to ninety five per cent. of the value of the works. It further provided the manner of ascertaining the value in case of purchase by the city, and also provided that if the city should not avail itself of its right to purchase the works at the end of twenty years, it should renew the grant for twenty years more. And further, that a renewal should not be considered until the last year of the franchise.

The company was authorized to take water from the Missouri, the Kansas or the Blue River, or all of them. The Kansas river is wholly within the state of Kansas; any location upon the Missouri river was at that time not to be considered on account of the great expense; the Blue river was in no respect suitable, therefore the water supply was taken from the Kansas river, which is wholly, as before stated, within the state of Kansas, upon the approval of the officials of Kansas City, in terms as follows :

Extract from report of Water Commissioners, June 6, 1874.

" " "We hereby consent, on the part of the city, to the selection of the point designated and adopted by you from which to take water for the supply of the city and its inhabitants. (Signed) J. E. MARSH, President.
W. P. MOORES.
C. M. FERREE, Secretary."

As the city increased in population, danger of pollution of the supply became imminent, and a clamor was made for a better supply. The company was confronted with a serious dilema in the fact that another company had established a plant on the west side of the Kansas river, in the state of Kansas, and had exclusive rights in Wyandotte and Armourdale, (now Kansas City, Kansas,) and the burning question was whether to take the new supply from a point higher up the Kansas, river, or tunnel the Missouri river and take the supply from a point opposite Wyandotte on the Missouri side, or to endeavor to get a right of way to bring the water through Wyandotte from a point above the sewerage of Wyandotte (now Kansas City, Kansas.)

The result of careful investigation and much study, about which I will speak more in detail hereafter, was that in 1885 the company acquired by purchase the works of the Wyandotte Water company, a Kansas corporation, and erecting a pumping plant and settling basin on the Missouri river above Wyandotte; brought the water down through a thirty-six inch pipe through Kansas City, Kansas, to the original pumping station near the Kansas river, and from that point distributed Missouri river water as it had hitherto distributed water from the Kansas river. The change from the old source of supply to the new was celebrated October 18, 1887, and applauded by everyone.

This change was made in response to a public demand, at an expense of, I should say, over $1,000,000, and at that time it was presumed that having a perfectly pure source of supply, ample subsiding reservoirs and adequate pumping machinery, agitation would cease and the company could enjoy the benefits of its enterprise.

The two systems being owned by the National Water Works Company, of New York, it was and is a matter of economy to operate the two systems as one or in conjunction, but the system can be disconnected at any time, leaving two entirely separate plants.

Both of these cities prospered greatly, and keeping up with this growth, the company put about all of its net earnings into the ground and in machinery, which increased the value of the plant, but left little or nothing for the stockholders, who never dreamed that this splendid enterprise in the interest of Kansas City would so soon be denounced as a trick and a scheme to prevent the city from exercising its option to purchase the works.

The combined plants now represent a pumping capacity of
67,000,000 gallons per day,
174 miles of pipe,
1,646 fire hydrants.

That part of the system east of the Kansas River, and including the new works above Wyandotte, (Quindaro) and the main conduit from thence to the old Turkey Creek pumping station, including Kaw Point station, represents a pumping capacity of
63,000,000 gallons per day,
142 miles of pipe, and
1,416 fire hydrants.

with settling basins and storage reservoirs of a capacity of 86,000,000 gallons, and this is the plant the value of which is proposed to be destroyed and superseded by one to be owned by the city, at a total cost of $2,000,000.00, having a pumping capacity of
44,000,000 gallons per day vs. 63,000,000 gallons per day,
120 miles of pipe vs. 142 miles of pipe,
1,260 fire hydrants vs. 1,416 fire hydrants,
30,000,000 gallon subsiding reservoir vs. 86,000,000 gallons.

A few years ago the city extended its limits, and water mains and fire hydrants were speedily ordered by the city. About ten miles of pipe and eighty-nine hydrants were laid and set. Subsequently the supreme court declared the extension illegal, thus depriving the company of hydrant rentals within that extension.

For three years there has been an every-day agitation of the water works question. That is to say, an element of disturbers of contract

relations began to agitate city ownership; the proposition was popular, and the sentiment grew with alarming rapidity and incredible violence. At first some sensational newspapers vied with each other in abuse of the water company and advocacy of municipal ownership. Water takers were interviewed and made to say the meanest and most contemptible things—things which had never occurred, many of which articles grossly misrepresented the persons interviewed. The story of the rise and fall of sensational newspapers that thrived for a time, and of the demagogues who also became famous in the interest of "the dear people," but who have been relegated to the shades of private life and are now growing up with the country would be interesting local reading. But notwithstanding the fact that the dead and dying are all around us, the seed of discord had been sown and the result is, the little cloud, not larger than a man's hand ten years ago, has grown into a torrent like that witnessed by the inhabitants of Jezreel in the time of Elijah, Ahab and Jezebel.

The city charter adopted since the contract of 1873 provided for the purchase of water works, and for the renewal of the contract, but did not provide for making a new contract or for building new water works. The people became possessed of the idea that inasmuch as the renewal of the contract could not, by its terms, be considered until the last year of said contract, that if action should be so delayed, the city would be at the mercy of the water company, which would dictate the terms of such renewal, for the reason that the city would not then have time in which to construct its own works and be ready to operate same by the time the existing franchise expired, viz., October 27, 1895. Therefore at an election in 1890, the charter of the city was attempted to be amended, giving the common council further powers, to wit: To make an entirely new contract, or to provide for constructing and operating a plant.

The language of this so-called amendment, as it relates to the making of a new contract, is as follows:

"Such contract shall contain a provision reserving to the city the right, at its option, at any time, to acquire and become sole owner of such portion of the water works of said corporation as may at the time of said purchase be situated in the *state of Missouri*, on paying a fair and equitable value therefor."

The language of the existing contract, as it relates to the city's right to purchase, is as follows:

"The City of Kansas hereby reserves to itself the right, at its option, and at any time, to acquire and become sole owner of said water works, including all extensions and enlargements thereof, and everything of every nature and description belonging and pertaining thereto, on paying therefor the fair and equitable value thereof."

The provision as to how the value may be determined is the same in each case.

The ringleaders of the agitation apparently sought thus to entrap the company into a new contract, reserving the right to buy a part of the works, and having secured that much they would proceed next day to make the purchase. The part thus purchased, being severed from its source of supply would have little value, and the city having little money could thus possess itself of a valuable property without quibbling over "fair and equitable" values.

Before the vote on this amendment was taken, the company notified the public through the press that the company would decline to make such a new contract. Nevertheless the warning was unheeded, and at a cost of several thousand dollars, the amendments were voted by a large

majority. Shortly thereafter, a pretended but insincere effort was made upon the part of the city officials to make a new contract. The company was invited to state the terms upon which it would make a new contract *under the amended charter.*

To which the company replied to the committee of the common council, a committee of the commercial club, and through the newspapers at various and sundry times, in substance as follows:

"If it can be legally done, (that is to say, if the amendment to the charter can be reenacted so the objectionable conditions can be eliminated) we will make a new contract on better terms than the existing one provides, which binds the city to a renewal, unless the works are purchased.

"We will duplicate the rates of St. Louis, a city thrice the size of Kansas City, and owning its own water works.

"We will leave the matter of rates, public and private, to experts mutually chosen, or,

"Will duplicate the average rates of ten cities of similar size and topography."

The council summarily dismissed the matter and succeeded in working up through a venal and mercenary press, a sentiment unworthy of an intelligent and otherwise honorable, but very busy people, unfairly claiming that the company had declined to make a contract unless it could dictate an amendment to the city charter—an unheard of piece of impudence and dictation upon the part of the company, etc. Of course by putting it in that way, without explanation, it had all the effect desired. It was popular, and there are but few politicians with sufficient backbone to stand by the right, when to do so will lose them votes or patronage.

The committee of the commercial club was composed of six prominent, active business citizens; men of wealth, influence and of equal general intelligence. Five of these met and discussed the whole question with the president of the water company, who came out from New York by invitation, having in view the settlement of this vexed question. Four of these, after due consideration, advised in their report the making of a new contract.

One of them made a minority report, recommending that no contract be made, but that immediate steps be taken to construct a new system of water works for the city.

Prior to this action an association of citizens calling themselves "The Citizens League," organized ostensibly for the purpose of purifying politics and otherwise influencing city legislation, and into this organization a goodly number of well-meaning citizens were induced to enter, not at first realizing its intent. The minority citizen was a member of this League, and also a member of the commercial club, and when these reports were to be acted upon by the club, there were said to be more members of the "Citizens League" present and voting than of the commercial club, resulting in the almost unanimous adoption of the minority report. The outsiders thus captured the meeting, and had everything their own way. The citizens league has never been known to pretend to exert its influence in any other department of municipal legislation.

The city press, for a number of years of this intemperate controversy, was divided. Those advocating moderation and caution in acting upon so important a matter as repudiating a contract were charged by the other side with being bought and owned by the water company. Finally the pressure of public sentiment was so great that every newspaper either

became silent upon the question, or fell into line advocating city ownership at all hazards, thus illustrating the deplorable fact that the press nowadays *follows* rather than *leads* public sentiment. The community became practically coerced and subjugated to one line of policy.

Leading attorneys employed by the city gave their opinion that the water company, having gone into another state for a water supply and having connected the plant of the National Water Works Company, which the city had reserved the right to buy, with the Kansas City, Kansas, system, had violated its contract and the city should proceed to confiscate such part of the plant as might be found useful in connection with a new supply to be constructed by the city, or to construct an entirely new system and repudiate the contract of 1873.

This opinion, notwithstanding the following ordinance adopted by the city council of Kansas City, Kansas, by authority of the state legislature:

"That for and in consideration of the sum of $10,000 to be paid, the City of Kansas City, Kansas, does hereby sell and transfer to The National Water Works Company of New York, its successors and assigns, whether such successors and assigns be a natural or an artificial person, or a municipal corporation located in this or any other state, the right to lay and maintain water mains under or over any stream, and along, upon and across the streets, alleys and other public grounds of the City of Kansas City, for the purpose of conveying water to any city in this state or any other state. And there is also sold and transferred to The National Water Works Company of New York, its successors and assigns aforesaid, the right to maintain any and all water mains heretofore laid under, along, upon or across any such streets, alleys and other public grounds, * * * * and until said company, its successors and assigns shall elect to wholly remove its said water mains."

The attorneys for the water company, including the eminent Judge John F. Dillion, gave it as their opinion that the city must either renew the contract or buy the works, and that the contract of 1873, as amended from time to time, was valid and could be enforced.

In February, '90, Engineers Donnelly and Pearsons were called upon by a citizens' committee to estimate the cost of a new system, taking the water from the opposite side of the Missouri river. This estimate was $2,499,998, being only $2 lesss than $2,500,000, and for convenience we will call it $2,500,000, which was at that time the limit of the debt making power of the city. The details of this report are omitted for want of space.

Following this was a similar estimate made by City Engineer Butts, practically confirming that of Pearsons and Donnelly.

The constitution of the State of Missouri limits the debt making of municipal corporations to 5 per cent. of the taxable property therein. The estimate of the city engineer having been made, requiring $500,000 in excess of the amount available, it seemed a trifle embarrassing for a time, but shortly thereafter the supreme court decided the extension of the limits illegal, leaving outside of the legal limits about ten miles of water pipe and eighty-nine fire hydrants, whereupon the city engineer caught his wind and upon a reconsideration said that $2,000,000 was quite sufficient.

Query: If $500,000 is a fair allowance for ten miles of pipe, would $2,000,000 be sufficient to lay 120 miles?

In April, 1891, the city voted favorably upon a proposition to issue bonds to the amount of $2,000,000 (4 per cent. currency) to construct water works. In June, 1891, the city employed a commission of hydrau-

lic engineers at an expense of $100 per day, each, to answer some questions which will next follow:

August 24, 1891, the city council passed an ordinance indicating the information it desired of these experts, which was as follows:

WHEREAS, On April 28, 1891, a proposition to issue bonds to build water works was carried by a large majority of the voters of Kansas City, Missouri, and

WHEREAS, About June 1, 1891, the common council passed an ordinance authorizing and directing the board of public works to cause to be made surveys, plans, details and specifications for the construction of water works for Kansas City, Missouri, and appropriating $7,000 to pay for said information, and

WHEREAS, The board of public works in pursuance thereof have secured the services of a commission of expert hydraulic engineers of national reputation, who are soon to be called upon to furnish the city with necessary information to enable it to proceed intelligently in the matter, therefore

Be it Ordained by the Common Council of Kansas City:

SECTION 1. The board of public works are hereby instructed to obtain from the aforesaid commission for the information of this body and citizens and tax-payers of Kansas City, the following:

1st. What system of water works is best adapted to Kansas City, Missouri.

2d To designate the best location for the intake-crib, pumping station and settling reservoirs, also the pipe line and tunnel.

3d. What capacity and kind of pumps, capacity and kind of reservoirs, amount of land, kind of buildings, description of river crib, size of pipe, size of tunnel, all cost of the same completed, with plans and specifications and details. In case of doubtful expense, give a minimum and maximum estimate of cost.

4th. Cost of an entire new plant within and without the city limits, land, buildings, reservoirs, stand-pipes, mains, hydrants, valves, etc., etc., suitable for a city of 200,000 inhabitants, as substantial and covering as much area as the plant of the National Water Works Company, of New York, within the city limits at the present time. (Note: It will be understood that the third question refers to the plant in Claycounty, and ques-questions refer to both inside and outside of city limits.)

In addition to the information desired by the council, the board of public works added many other questions, among which was the following:

"What approximate value should be placed on the pipes, hydrants, etc., of the National Water Works Company now in use which the city must buy?"

After collating all these, a resume was agreed upon as embodying all questions:

1st. What system of water works is best adapted to Kansas City, Missouri?

2d. To designate the best location for the intake-crib, pumping station and settling basins or reservoirs; also pipe line and tunnel.

3d. Advisability of constructing tunnel, or otherwise crossing the river.

4th. What capacity and kind of pumps, capacity and kind of reservoirs, amount of land, kind of buildings, description of river crib, size of pipe, size of tunnel, all cost of the same completed, with plans and specifications and details. In case of doubtful expense giving a minimum and maximum estimate of cost. (Note: It will be understood that these questions refer to the plant in Clay county, and to both inside and outside of the city limits.)

5th. The cost of an entire new plant within and without the city limits; land buildings, reservoirs, stand-pipe, mains, hydrants, valves, etc., etc., suitable for a city of 200,000 inhabitants, as substantial and covering as much area as the plant of the National Water Works Company, of New York, within the city limits at the present, time.

6th. Any information in regard to special construction of any part of the plant which may have advantages and so proven by experience. Also same in regard to machinery, or in fact to any appurtenances which may appear advisable for the adoption of the best methods in use.

7th. What approximate value should be placed upon the pipe, hydrants, etc., of the National Water Works Company, now in use, and which the city must buy?

8th. Cost of plant capable of supplying a population of 200,000, with details as to syphon, intake-crib, mains, valves, hydrants, pumps, pump-houses, lands, railroad tracks, and other appurtenances for the operation and successful distribution of water as may be advisable under the circumstances for the supplying of water for Kansas City, Missouri.

9th. Can the complete system be constructed and purchased for the amount available.

A communication followed this from the president of the board of public works, requiring that the report be made with such care that an intelligent estimate of the cost and general construction could be understood by non-experts as well as by professional engineers. (It must have been gratifying to the president of the board to find that this suggestion was adopted in spirit and letter.)

Following this was a communication from the city counsellor directing the engineers to give the value of only such portions of the plant of the National Water Works Company in the state of Missouri as the city could, in the judgment of such engineers, advantageously use in the new system.

It would be cruel to present this report in full here, and I shall undertake to discuss only such portions of it as to my mind are pertinent to the occasion.

Answers :

1st. For distribution, the direct pressure system, without any stand pipes or reservoirs.

3rd. In favor of a tunnel under the Missouri river.

4th. They advised three vertical, crank, fly-wheel engines of 12,000,000 capacity, each, for low service; three vertical, triple expansion engines, of 10,000,000 capacity, each, capable of delivering this volume of water for domestic purposes against a head of 340 feet above city datum, requiring a pressure of 147 pounds. For ordinary fires, 430 feet or 185 pounds pressure, and for extraordinary fires 455 feet or 197 pounds pressure; for reservoirs, or rather settling basins, four basins of 10,000,000 capacity each, 110 acres of land in Clay county, and a triangular piece of land between some railroad tracks within the city limits, near Broadway, the latter for high service station.

5th :

Inlet tower, 200 feet of 48 in. pipe, and foot bridge	$ 66,500 00
Foundations for three engines at basins	57,276 50
Buildings for three engines	9,620 00
Boiler-house and smoke stack for three engines	12,000 00
Railroad track and coal sheds	1,200 00
Three engines	150,000 00
Four settling basins	393,058 00
48 in. conduit line, 12,000 ft., one gate	133,825 00
2,020 ft. of tunnel and two shafts	120,684 00
Excavation, high service station, foot of Washington street	19,950 00
Foundations for four engines	35,702 00
Four engines, boilers and appurtenances complete	400,000 00
Engine and boiler-houses and smoke stack	97,520 00
Pipe for distributing system, 30 to 6 in. 648,400 ft., 120 miles, 23,741 tons @ $24.50	581,801 50
Laying 646,400 ft. of pipe at prices varying from 25c to $1.25 per ft	215,812 50
15,654 cu. yds. rock excavation for mains @ $2.00 per yd	31,308 00
999 valves, from 30 to 6 in	17,429 00
1,260 6-in. hydrants, @ $40.00	50,400 00
525 tons special castings, @ $60.00 per ton	31,542 00
	$2,425,628 50

It is proper to allude to the report of Donnelly and Pearsons in connection with this as it was also intended to show how little the work could be done for.

They provide for fifty per cent. more capacity in the settling basins, and their items, except as regards pipe, are generally lower. Two items, however, need attention. They allow for taking up and relaying pavement.

$135,000; the increased mileage of pavement and estimates made elsewhere show that this should now be about $160,000. Trenching in rock, of which they had data, both as to amount and cost, increases the other estimate about $15,000, making about $175,000 to be added for these items. Add for land, (not estimated) say $125,000, and for interest during construction, engineers' salaries, incidentals, etc., usually estimated at ten per cent. and it brings their estimate without other changes than the addition of these necessary items, to the sum of $2,998,185, practically $3,000,000. And what have we for these $3,000,000? Works in which the settling basin capacity is two-thirds of that in present use, the loss of the present elevated storage which has been found so important in practice, that even when out of use for the short time required in cleaning, extra precautions are taken beforehand to see that nothing is left undone or uncared for to maintain safety during the interval.

New and untried pipe subject to unusual and severe conditions.

Engines of a class which have never been used for direct pressure service, and which from the conditions under which they work, are probably the least fitted for this work of any engines ever made for it.

In short, supplanting a plant of tried and proved efficiency, the construction and operation of which has been the result of nearly twenty years of study and experience of some of the best engineers of the United States, by untried, unproved plans and machinery devised by eminent engineers but without a practical knowledge of the difference between direct and reservoir or stand-pipe service on so large a scale as predicted, and containing elements of doubt and uncertainty.

When this is done the city will have two full sets of water works, the present company of course doing what they can to keep their place. We are blamed, of course, for not letting the opposition confiscate our property, but it is human nature to avoid loss when practicable.

In answer to the 7th question, to wit: "What approximate value should be placed on the pipes, hydrants, etc., of the National Water Works company, now in use, which the city must buy?" under direction of the city counsellor they proceed to state in so many words that about 20 miles of the pipe system of the National Water Works company might be used in connection with the proposed new system, together with 284 of the 1,416 fire hydrants. The value of this property is summed up as follows:

9,841 tons of pipe, 30 to 6in., at $24.50 per ton	$241,104 00
Cost of laying above	106,685 00
248 hydrants, at $40 each	9,920 00
	$357,709 00
Less 10 per cent. depreciation, 7,081 tons	17,348 45
	$340,361 05

They reject all pipes of four inches and less, all four inch hydrants, all pumping machinery and reservoirs, the location of the new plant being on the North side of the city and that of the National Water works company on the West side, including a storage reservoir within the city limits. Doubtless, under instructions given, they were obliged to reject all these, more on account of their location than for any other reason.

The large mains of the water company extend from west to east,

while those of the proposed new system extend from north to south. There was consistency in rejecting these, also.

However, they neglected answering the legal questions as to what the city "must buy." In this respect they might have relieved the situation somewhat by replying that the city "must buy" not only a few pipes and hydrants, but the whole plant if any.

On page 18 of their report, they say :

"As regards the distribution system of the National Water Works Company, we find that a large percentage thereof consists of pipe of four inches and less, which is entirely inadequate, on account of loss of head."

The writer finds this large percentage of pipe of four inches and less to be 21 per cent. while the percentage of pipe of the same diameter in the plant constructed and maintained by one of these experts is not far from 30 per cent. The city of Louisville has in its system about 50 miles of these small pipes, and about 8,000 feet of these sizes were laid as late as 1890. Cincinnati has over 100 miles of these sizes. The pressure carried in Louisville is 80 pounds at the pumps, the gravity pressure considerably less; while the domestic pressure at the pumps in Kansas City is 130 pounds, making the use of four-inch pipe much more permissible in Kansas City than in Louisville, or Cincinnati.

The report of the water commisioners of Kansas City, of May 3, 1875, has this item :

"The size and capacity of main and distributing pipe, as above given, are, we find, two and one-half times the average size of those of Detroit, and twice the size of the water pipes of Chicago, and larger than the average size of most of the cities of the United States."

In September, 1889, the annual convention of fire engineers was held in Kansas City, which brought firemen from all over the United States. A display was made of the fire pressure in the most elevated parts of the city, and almost to a man they pronounced it the best they had ever seen.

Experienced fire chiefs from Chicago, St. Louis, Louisville, Lowell, Atlanta, Holyoke, Galveston, New Orleans, Memphis, Albany, N. Y., Springfield, Ill., Detroit, New York City and Denver, witnessed the increase of fire pressure at the pumps, upon an alarm, from 130 to 175 pounds in eleven seconds, and all gave the works the highest praise.

In December, 1890, Mr. John W. Smith, ex-assistant chief of the fire department of Brooklyn, N. Y., and at the same time general inspector for the National Board of Underwriters, made a critical investigation of the water works of Kansas City, and said :

"The water supply here is the best I ever saw. Yesterday I saw a test of the water supply and pressure from one of the highest elevations of the city, and a stream was easily thrown 150 feet. With such a splendid water supply and pressure you incur none of the liabilities that come with the use of steamers, and the delays that often accompany the work of getting a strong stream by use of engines is entirely unknown by having such direct pressure as you have here."

Since the date of this report the company has laid only 635 feet of pipe, and the works are in every respect as efficient as they were then, and yet the commission adjudged these pipes of no value.

In addition to this proposed picking out of a water works plant, (which the city has the right to buy, with all extensions and enlargements thereof, at an equitable valuation—worth several million dollars)

a few pieces of pipe and a few hydrants, their generosity seems to have gotten the better of them in the following:

"As to the valves, branches, reducers, bends and other special castings, we would recommend that so many as are connected with the lines of pipe above estimated as useful, be paid for at prices fixed in the estimate of cost for the new water works plant, and their number and weight be accurately determined at such time as they may be purchased."

QUESTION 8. Cost of plant capable of supplying a population of 200,000, with details as to syphons, intake-crib, mains, valves, hydrants, pumps, pump-houses, land, railroad tracks, and other appurtenances for the operation and successful distribution of water as may be advisable, under the circumstances, for the supplying of water for Kansas City, Missouri.

ANSWER: The complete answer to this question can be found in the answer to the fifth question. If, however, the expression, "Advisable under the circumstances," is intended to refer to the present needs and population of the city, we refer you to question number 9.

QUESTION 9. Can the complete system be constructed and purchased for the amount available?

Answering this, the commission proceeds to inform the public that there is no necessity for a plant to supply 200,000 people, and present a modified estimate to meet present demands, reducing the capacity of settling basins from 40,000,000 to 30,000,000 gallons, providing two low service engines instead of three, and two engines for high service instead of four, as follows:

Inlet tower, complete	$ 66,500 00
Foundations for three 12,000,000 gallon pumping engines at settling basins	57,276 50
Buildings for two engines and boilers, smoke stack, tracks and coal sheds	18,320 00
Two engines with boilers and appurtenances, complete	100,000 00
Three settling basins	303,000 00
48-inch cast iron pip- conduit line	133,825 00
River tunnel and shafts, complete	117,434 00
Preparing site for main pumping station	9,975 00
Foundations for two engines and engine house	17,851 00
Two engines with boilers and appurtenances, complete	200,000 00
Engine and boiler houses and one smoke stack	49,960 00
Water pipe distribution system, complete	928,293 00
Making a total of	$2,002,434 50

In the system of direct pressure supply, devised by your commissioners, there should be provided means for relieving the distribution in the low levels of the city, from the excessive pressure which will result from maintaining constantly, and especially during the prevalence of fire, a proper pressure for that in the higher levels. This should be accomplished by the introduction of proper pressure regulating valves, located at such points in the new distribution as will reduce the pressure in said lower levels to such an extent as may be found desirable.

The commission here suggests provision for regulating valves in an indefinite way, and fails to estimate a dollar of cost. They do not estimate a dollar for lands in the city or out of the city, nor do they estimate anything for contingencies, although over $20,000 has already been expended in that respect.

This report is concluded with the recommendation that provision be made to put the work under contract at once which, so far as the writer is able to discover, is a recommendation entirely unasked for by anyone.

If there was anything lacking to accelerate and unitize sentiment in favor of "owning our own water works," it was amply furnished in this report. The testimony of engineers of such standing could not be faulty. The amount at the disposal of the city was ample, and no amount of argument to the effect that those engineers had given a mini-

mum rather than a maximum cost, and had omitted many essential items, could find lodgement or counter-balance the weight of the report.

The effect upon the populace was similar to that produced at the beginning of the late war or rebellion, so-called, when Fort Sumter was fired upon. It also "fired the northern heart," but I notice the shooters got the worst of it in the end.

Shortly thereafter the aforesaid currency bonds were ordered issued and sold. Bids therefor were to have been opened on the 5th of January. Receiving no bids, the opening was postponed until the 5th of February. Still receiving no bids, at a late election these bonds were ordered cancelled, and an entirely different issue for the same amount, bearing 4½ per cent. interest, and payable in gold, were voted. At the same election $150,000 4 per cent. currency school bonds were ordered issued.

Query: If 4 per cent. currency school bonds will sell, why is it necessary for Kansas City to pay 6% per cent. in gold?

The agitation of the silver question could not affect the one without the other. The real fact was, the city bonds were clouded by injunction suits, and their issue was believed to be illegal.

It is a significant fact that in April, 1873, before the contract was made, the city called upon Engineer T. J. Whitman, recently deceased, of St. Louis, to make surveys and plans for a water supply for the city, and his report is still on file. He proposed to take the water supply from the almost identical spot from which it is now taken. The system outlined by Mr. Whitman was for eighteen miles of pipe, 350 hydrants, a stand-pipe, settling basins, and a delivery capacity of engines of 5,000,000 gallons daily, and he estimated the cost at $1,011,832.

In this estimate there was no tunnel or unusual difficulties nor expensive lands to provide as in the present case, and the state line is exactly where it was then.

Now we are told that a system of 120 miles of pipe, 1,260 hydrants, low service pumping capacity of 24,000,000 gallons daily, high service of 20,000,000 gallons daily, reservoir capacity of 30,000,000 gallons, and a 2,000 foot tunnel under a treacherous river bottom, with shafts and all appurtenances, can be had for $2,000,000.

During the time the company was considering the removal to a new source of supply, it had under consideration a tunnel under the Missouri as now proposed. Numerous borings were made to ascertain the strata beneath the river, under the direction of General Sooysmith, who had much experience with the bed of the Missouri river in building bridges; Mr. James Campbell, then chief engineer of the Croton aqueduct, of New York, who also had much experience in tunnel driving, together with Mr. F. E. Sickles, of New York, a man of national reputation, and at present the company's chief engineer; and some others, spent some time at Kansas City studying the situation, and although the company was desirous of avoiding the state line especially as another company was owning and operating a plant in Wyandotte, now Kansas City, Kansas, these engineers declared the plan of tunneling of doubtful result, and were fully agreed that as an engineering proposition it was not practicable, and advised the company to abandon the idea and purchase the Wyandotte plant, which was shortly thereafter consummated.

They said that a tunnel might be driven at a comparatively small cost, and it might cost a million of dollars. It could not be estimated intelligently, and with safety to reputation. However, the company was willing to undertake the matter if a responsible contractor could be found who would insure a tunnel at a reasonable price, but there were none to be had.

We are now told that a tunnel 2,000 feet long can be driven for $60,000, although time has changed none of the conditions.

A mention of another commission will here be interesting, and for this puspose I will quote from a recent criticism of the report of the Kansas City commission, which appeared in the Kansas City papers:

"It is appropriate in this connection to refer to a report of date February, 1889, by a similar commission appointed by the city of Cincinnati, upon a similar question:

"The conditions upon which the report is based are so nearly similar to those which were under the consideration of the Kansas City commission as to form a splendid basis for comparison. At Cincinnati, as in Kansas City, a supply was sought from the river at a point opposite and above the city; the water was to be settled in reservoirs and then conducted by means of pipe lines and tunnels to the city reservoir for distribution. No distribution system figured in the Cincinnati report, but the water was to be delivered to a point which finds its Kansas City counterpart in the proposed Washington street station. The only difference is one of quantity of supply, that of the Cincinnati reservoirs being 50,000,000 gallons, and those for Kansas City 30,000,000 gallons."

The Cincinnati commission had for its president one of the gentlemen who later served on the Kansas City commission. The others were:

Henry Flad, of St. Louis,
A. Ftely, of New York,
Chas. B. Brush, of New York,
Dewitt C. Cregier, of Chicago.

The report of cost for the Cincinnati supply as estimated by this commission (composed of the foremost men of the times in water supply engineering) is given below, and opposite each item is set the amount estimated by the Kansas City commission for the same details:

	Cincinnati.	Kansas City.
Real estate, including right of way	$ 75,000	$..
Buildings at supply station	235,000	75,596
Intake tower	100,000	66,500
Machinery and boilers at supply station	900,000	100,000
Settling reservoirs	1,350,000	303,000
Pipe lines to city distributing station	416,000	133,825
Tunneling river	400,000	117,434
Gate wells, stop gates, etc	50,000	
Engineering and contingencies	401,200	
	$5,927,200	$796,355

"Note.—From this table is omitted an item of $486,000 included in the Cincinnati report for piping to Eden Park reservoir, since there is no necessity for a kindred expenditure at Kansas City."

It seems to the writer that the late report of the Kansas City commission, compared with that or the Cincinnati commission, must impress the conviction that the discrepancy is a noted one. To say that to tunnel the Ohio at Cincinnati would require $400,000 as against $117,434 for a tunnel and shafts for the Missouri river at Kansas City will be received with surprise.

Likewise, that at Cincinnati a provision for "engineering expenses and contingencies" of $401,200 as against no amount at Kansas City.

And likewise, that it should cost $1,350,000 for settling basins at Cincinnati as against $303,000 at Kansas City, especially as the common belief is that the Missouri river carries more sediment than any other river in the United States.

In meditating on these contrasts, it has occurred to the writer that the Cincinnati commission had in view a "maximum and minimum cost"

which may not have been considered by the Kansas City commission, although it was asked of them.

(Question 4.—In cases of doubtful expense, give a maximum and minimum estimate of cost.)

The report of the Kansas City commission has recently been reviewed by the following engineers: A Fteley, of New York; C. H. Ledlie and Henry Fladd, of St. Louis; C. H. Myers, of New York; Peter Milne, of Brooklyn, and L. H. Gardner, of New Orleans, who all agree that many essentials to the estimate were omitted, and pronounce unqualifiedly that no such system as outlined can be built for $2,000,000 and if constructed as planned would be inadequate and insufficient.

The writer has taken the trouble to ascertain from statistics, (Manual of American Water Works, 1890-91) some information in regard to the cost of building water works. He finds there are twenty-nine cities having a population of 100,000 and over, aggregating a population in twenty-five of these, and including two cities of the province of Canada (leaving out of the count San Francisco and Washington for lack of material informotion in the tables, and also leaving out Kansas City) as shown in the following table of twenty-seven cities, aggregating a pupulation of over 9,000,000, or about forty-five per cent. of all cities and towns supplied with water works, that the cost of water works per mile of pipe has been $26,289, varying according to conditions from $8,500 to $59,820. Some of these with unusual constructive difficulties somewhat similar to those prevailing at Kansas City, materialize in this respect as follows: Cincinnati and Jersey City, each, $30,000; Louisville, $37,000; St. Louis, $38,000, and Montreal $41,000 per mile of pipe. The average is reduced by such cities as Detroit, Minneapolis, Chicago, Milwaukee, Denver and Toronto, where expensive settling basins and maintenance are not required, where the cities are comparatively level and pipe laying cheaply done. This average of $26,289 contrasts so sharply with the estimate of the Kansas City commission, $16,666 per mile of pipe, that from all information received to date, the writer is willing to go on record to the effect that the amount is wholly inadequate, and that it will never be accomplished. Cheap pipe is not the only item entering into the construction of water works.

CITIES.	Population.	Miles of Mains.	Cost of Works.	Approximate Cost Per Mile of Pipe.
New York	1,515,301	667	$ 39,900,000	$59,820
Chicago	1,099,850	1,205	16,902,190	14,000
Philadelphia	1,046,964	960	18,750,000	19,500
Brooklyn	806,343	416	15,485,000	37,000
St. Louis	451,770	353	13,145,340	38,000
Boston	448,477	650	23,000,000	36,000
Baltimore	434,439	422	12,018,377	30,000
Cincinnati	296,908	287	8,697,597	30,000
Cleveland	261,353	324	5,989,255	19,000
Buffalo	255,664	302	6,142,085	20,000
New Orleans	242,039	76	2,420,000	32,000
Pittsburg	238,617	192	4,582,900	23,000
Detroit	205,896	362	3,631,000	10,000
Milwaukee	204,468	190	3,638,432	15,000
Newark	181,830	176	3,532,000	20,000
Minneapolis	164,738	166	1,422,000	8,500
Jersey City	163,003	160	4,950,000	30,000
Louisville	161,129	150	5,697,597	37,000
Omaha	140,452	157	3,000,000	19,000
Rochester	133,896	221	4,330,304	20,000
St. Paul	133,156	133	3,095,000	23,000
Providence	132,146	226	7,156,000	31,500
Denver	106,713	225	3,707,000	16,000
Indianapolis	105,436	84	2,200,000	27,000
Allegheny	105,287	90	2,225,000	24,000
Toronto	144,028	230	3,150,478	14,000
Montreal	216,650	178	7,443,329	41,500
	9,396,533	8,602	$226,139,984	

Average cost per mile, $26,289.

Meantime, under the advice of the commissioners and lawyers, the recently voted bonds were ordered placed on the market. If they succeed in placing them the money will be spent, but the general conviction, at home and abroad, is that the amount will not nearly give the city an adequate water supply.

And this is "The Kansas City Case," which will probably cease to be an exception in the future. The tendency of the age is antagonistic to monopolies. The socialistic cry is for a division of the spoils, and the spoils are the property of private corporations.

In conclusion I will quote from a well known authority upon the subject of "municipal franchises for quasi-public works," who says :—

"Men so dishonest as to be willing to divert by force of legal enactment a portion of the profits of those who incurred, to those who have not incurred a risk in their production; men so incapable of correct judgment as to denounce rent, interest and profits as robbery; men so prejudiced against monopolies, that they regard them with fear and hatred; men so in sympathy with the sufferings of the poor that they are blind to the cause of their sufferings,—are not safe guides of public opinion.

"The immutable law of nature that brings men into physical existence and excuses him from it, but not until another has been supplied to take his place, would have been recognized by making a perpetual provision for perpetual needs. The municipality into which men come, out of which men go, like the eternal life of time, lives on and shall forever live as long as man remians. Co-existent with the life of a municipality are its needs, and should be the life of municipal franchise,—corporations organized to supply them."

Instead of making perpetual franchises, according to the policy advocated by Mr. Foote, thus enabling the monopoly to perform the best service at the least cost to consumers, the universal tendency is to make

its life short, and otherwise to hamper and restrict unreasonably under the burdens of technical requirements.

So long as the monopoly proves to be unprofitable, additional burdens are heaped upon it, and thus the private corporation struggles for life. If, finally, by reason of growth in population, good management or favorable local conditions or for other reason it becomes profitable, or is believed to have become so, those who have not incurred a risk, those who denounce the collection of revenues as robbery, those who are so prejudical that they regard monopolies with fear and hatred, are to be found promptly in the fore front demanding a change of ownership.

The subjugation of sentiment in favor of municipal integrity and common honesty is as much a crying need as a coerced respect, where ever necessary, for common decency.

(From the Kansas City Times, April 3, 1892.)

OPINIONS OF OTHER EXPERT ENGINEERS UPON THE COST OF WATER WORKS.

"An inquiry made by Messrs. F. J. Baird, F. A. Faxon, J. C. Horton, R. H. Keith, J. K. Burnham, W. E. Hall, L. R. Moore, C. J. White and J. M. Lowe, and other prominent citizens of Kansas City, in search of more light to a number of prominent hydraulic engineers and practical water works people has had the effect of producing replies from the following experts to date, a perusal of which will throw much more light upon the the subject than our people have hitherto had:

A. Fteley, Chief Engineer, Croton Aqueduct, New York.
Chas. H. Ledlie, Consulting Engineer, St. Louis, Mo.
Henry Flad, Consulting Engineer, St. Louis, Mo.
L. H. Gardner, Water Department, New Orleans, La.
C. H. Myers, Consulting Engineer, New York.
Peter Milne, Consulting Engineer, Brooklyn, N. Y.
The form of inquiry was as follows:

"DEAR SIRS:

The undersigned citizens of Kansas City beg to send herewith a copy of the report of a commission of October 24, '91, on the subject of the cost of a complete system of water works for this city, and would thank you to give your views as to its merits and reliability, relating to the suggestions therein made, both in relation to cost, and plan of system."

These opinions are presented to the public for their information and are as follows:

Opinion of A. Fteley, Chief Engineer of the New Water supply of New York City. Beyond all comparison the most extensive water plant on the continent.

"GENTLEMEN: NEW YORK, March 26, 1892.

After reviewing the general condition of the water supply of Kansas City, from its origin to the present time, from the standpoint of its general usefulness to the various communities supplied and without regarding the differences which now exist as to the several municipalities concerned, and to the various interests which seem to be conflicting, it preeminently appears that the transfer of the main pumping station from the well established shore of the Missouri river at Quindaro, which, from such data as I have been able to procure, seems to have been free for many years from any change due to the shifting of the river bed, to a point on the other shore about three miles nearer the city, which is exposed to such changes, which necessitates a crossing of the Missouri, and which would be more subject to sewerage contamination when the territory between Quindaro and Wyandotte stations becomes thickly populated, is a change to be avoided if it can be done consistently and without endangering the perpetuity of the water rights of Kansas City.

As, however, such a change has been recommended, owing to the inter-state questions which may arise in the future, to the detriment of the interests of Kansas City, the main questions at issue are whether the plan of work recommended by the board of engineers on October 24, 1891, is judicious, and whether it can be carried out within the limits of the expenditure mentioned.

First, as to the plan recommended.

They propose to make the city, with the widely different conditions of level and of water pressure which must obtain on account of the requirements of the fire service, depend on a single system of pumping plants and pipes, without reservoir or standpipes. To state such a proposition when the limits of pressure correspond to a range of heights between 25 feet and 455 feet above low water in the Missouri river, is to indicate at the same time the risks which would have to be incurred.

Such systems are in operation on smaller scales and within narrower limits of pressure, and, if no other means of supplying the city were to be procured, it might become proper to consider them; but the present case is different, and it would be injudicious to resort to such a plan and to incur unnecessary risks when other and safer means of managing the supply of the city are at hand. A division of the water supply in two pumping systems, a low service and high service, with the addition of at least one reservoir, would, in my judgment, be much preferable, and is decidedly indicated by the circumstances of the case.

Second, as to the estimate of cost.

The estimate of cost is too low. It omits essential features, such as the cost of land to be acquired, the necessary provisions to be made for unforseen contingencies and for the expenses of engineering and superintendence, and the payments of interest on moneys used during construction. It also undervalues the cost of certain parts of the excavation and of the laying the pipes and re-paving the streets. The cost of the tunnel and shafts is uncertain to a large extent, and is too low; the settling basins are planned on too small a scale.

In my opinion the cost of the work, as planned by the board of engineers, would be at least $3,000,000, and, if the necessary features omitted by them is taken into consideration, the total expenditures to be incurred would not be far from $3,500,000.

Respectfully Submitted, (Signed) A. Fteley.

Opinion of C. H. Ledlie, C. E., Member of the American Society of Civil Engineers. Approved by Henry Flad; St. Louis, Mo., ex-president of the American Society of Civil Engineers, and member of the Mississippi River Commission.

Having carefully examined the "Report of Commission of Hydraulic Engineers," dated October 24, 1891, I am of the opinion that the work outlined on page 12 of said report, estimated to cost $2,002,434.50 cannot be done for less than $2,608,539.82, and not then, should you meet with any serious obstructions or difficulties in the prosecution of the work.

Three engines should be bought in place of two at both high and low service stations. For with a consumption of 10,000,000 gallons in twenty-four hours, eight-tenths of which in all probability is used between 7 a. m. and 6 p. m., will require both engines to operate during that period of time to supply the needed quantity, and should one of the engines become disabled, the supply would fall far below the demand. The same reasoning is true for the third engine at the low service station

This would add between $150,000 to $175,000 additional to the estimate, therefore, to maintain the efficiency of the system for both domestic consumption and fire protection, it is absolutely essential that these pumping engines should be included in the first purchase, and not wait until the plant is in operation. No provisions seem to have been made for the repairs of the iron conduits, shafts or tunnel. Should it become necessary to make them, or clean out the deposits of sediment in the tunnel, which is unavoidable unless the indicated settling capacity be doubled, the question then naturally arises, what would the city do for water supply during these repairs?

This may be answered in three ways, viz:

First.—Take the water at the high service station directly from the river.

Second.—Build a duplicate tunnel and conduit.

Third.—Build on the high service side a storage reservoir holding at least a week's supply.

The first of these plans would be dangerous to the health of the city on account of the sewerage; therefore it lies between the second and third, and which of these would be better to adopt can only be determined after surveys and estimates have been made.

Therefore, if the water must be taken from the point indicated in the report, it is necessary to provide the money in the beginning for one or the other of these plans, if the city is to be assured of its supply without interruption.

This would cost at least $350,000 additional, if not much more. The estimates given in the report do not include anything for the repaving of the streets over the pipe trenches, for valve pits and boxes, setting fire plugs, engineering, re-placing gas pipes, sewers and other obstructions, of like nature. I do not find any mention in the report of who is to pay for the transfer of the domestic service attachments. I understand that there are nearly 15,000 of these, and if the city wishes private consumers to take water it will be obliged to pay the expense of transferring them from the present company's to the city mains and this will involve an outlay of at least $150,000. But should the city purchase the company's mains, which the report states will be of value to the new system it would reduce the amount of new pipe, etc., to purchase, but would likely

make little or no change in the final total of estimate, unless it is the repairs of streets included in the said estimate, which would amount to about $200,000.

The estimate of $2,600,000 gold dollars has been carefully prepared from such reliable data as I have had at my command, and where I have not been able to obtain authentical information, I have used the prices given in the report.

To this estimate must be added, if the city wishes an absolutely sure supply of water, the cost of the additional pumping engines and duplicate tunnel or reservoir. This will add to the estimate given above no less than $500,000 additional, to which must still be added the price of land and the transfer of services in case the city does not buy the company's mains.

It is almost self evident that to build a plant following the general outline given in the report, to insure the city a continuous supply of water, will cost not less than $1,100,000 in addition to the estimate given on page 22 of the report, should there be no street repairs on account of the purchase of the company's mains, this would reduce the last total to about $900,000 in excess of said estimate, and on the other hand the price of pipe is problematical, and the tendency is for higher rather than lower prices, and a rise of $5 per ton would add $115,000 to the cost. The land, I believe, from information I have received, could not be bought for less than $100,000.

In conclusion, I believe when the detail surveys, etc., are made and bids called for, they will exceed the estimate on page 22 of said report at least sixty (60) per cent., giving total of $3,200,000.

All of which is respectfully submitted.

St. Louis, March 28. (Signed) CHAS. H. LEDLIE.

I have examined the "Report of Commission of Hydraulic Engineers to the Board of Public Works of Kansas City Mo.," dated October 24, 1891, also the estimate and report of Mr. C. H. Ledlie, C. E., dated March 28, 1892.

I find the estimate of Mr. Ledlie just and fair, and the conclusions he points out in regard to omissions are, in my opinion, well founded.

(Signed) HENRY FLAD.

March 28, '92.

Opinion of L. H. Gardner, Sup't of the New Orleans Water Co., an ex-president of the American Water Works Association, and a man of large practical experience and observation in water supply subjects.

NEW ORLEANS, LA., March 26, '92.

I am quite familiar with the water supply of Kansas City; with the unusual varying topography of the city; with the character of the Missouri river water; with the geological formation of that section; with the constructive difficulties of supplying Kansas City with water; with the cost of works in other cities; with the report of October 24th, '91, of the commission, and with the members of the commission. My judgment of the performance is:

First--The report, as a whole, is a disappointment and a surprise, and seems to have been made to gratify public demand, rather than to convey useful and reliable information upon a grave subject involving important private rights, and large public expenditure.

Second—The plan proposed is one that will not be commended by engineers familiar with the situation, and with direct pressure systems. Such a system as is here proposed, does not exist anywhere in the world, and the best that can be said of it is, that it is likely to prove an expensive and dangerous experiment.

With a storage reservoir provided, with a supply already elevated, water would be available in case of fire, and it would be possible to save the city from a water famine in case of an accident to the tunnel or to any of the large mains, without elevated water from which to take suction, the result of lifting by direct pressure to an elevation of 455 feet is too extremely doubtful for safety.

Third—The proposed basins for settling the water are too small to furnish good water.

There is no provision for cleaning the tunnel, nor any provision for water supply during such cleaning, nor fire protection in case of serious accident to tunnel or large mains. There is no reason given for taking the water supply from the north side of the Missouri river. The shore on the north side is uncertain in its character. That on the south side is fixed, permanent, and accessible without a tunnel, which, in the estimation of many, is of doubtful construction. The data of geological formation under the river where the tunnel is proposed, is not of so thorough and reliable character as to justify the statement that it could be constructed for $30 per foot.

Fourth—The report omits many essentials to the construction of a complete system of water works, among which are the following:

For land for reservoirs and pumping stations,

For land for storage reservoirs, and its cost, within city limits.

For thirty inch pipe to and from reservoir to high service station.
For pipe distribution 30,000 tons.
For taking up and replacing pavements—sixty miles of trenches.
For extra expense in pipe laying in streets already occupied by gas and water mains, gas and water services, cable, electric and horse car lines, sewers, etc.
For pipe breakage and damage to persons and property.
For incidental expenses, attorneys' fees, inspection, supervision, engineering, condemnation proceedings, etc.
For valves, branches, reducers, bends and other special castings.
For pressure regulating valves, indefinitely mentioned (p. 22)
For interest on water fund during construction.
For adequate addition to settling basins.
For expense of service pipe for consumers.

When the full value of these are added to the estimate of the commission, it will be found that the cost will be nearer $3,500,000; and when built will, in my opinion, foot up more than that sum.

In my experience in private and public life, I have never before seen an estimate of this magnitude which did not contain a percentage for incidentals of at least ten per cent. This omission gives color to the suspicion that the main object seems to have been to build the works on paper for the sum at the disposal of the city, viz., $2,000,000.

Moreover, the commission, on page 21, have gratuitously answered a question not asked, i. e., "The cost of a supply for present population only." By this ingenious assumption, they proceed to reduce the cost to purse equivalent, independent of the information sought by the city authorities, to wit:

"Question 5. The cost of an entire new plant, within and without the city limits, land, buildings, reservoirs, standpipes, mains, hydrants, valves, etc., suitable for a city of 200,000 inhabitants, as substantial and covering as much area as the plant of the National Water Works Company of New York, within the city at the present time."

In reply to this question they make the cost $2,425,628, and omit the before-mentioned essentials to a complete system, and the gratuitous suggestion follows as before stated.

Fifth.—The report provides for a complete system of water works for Kansas City, on paper, at a cost of $16,000 per mile of pipe. In some other cities the actual cost per mile is reported as follows:

Louisville, Ky.	$36,000	Cincinnati	$30,000
Nashville, Tenn.	50,000	Washington City	46,000
San Francisco, Cal.	40,000	Harrisburg, Pa	33,000
Boston, Mass.	44,000	Lawrence, Mass	36,000
Lowell, Mass.	52,000	St. Louis, Mo	40,000
Brooklyn, N. Y.	34,000		

The average cost in seventy-five large cities is $25,190.

It is appropriate, in this connection to refer to a report of date February, 1889, by a similar commission, appointed by the city of Cincinnati, upon a smilar question.

The conditions upon which the report is based are so nearly similar to those which were under the consideration of the Kansas City commission as to form a splendid basis for comparison. At Cincinnati, as here, a supply was sought from the river at a point opposite and above the city; the water was to be settled in reservoirs and then conducted by means of pipe lines and tunnels to the city reservoir for distribution. No distribution system figured in the Cincinnati report, but the water was to be delivered to a point which finds its Kansas City counterpart in the proposed Washington Street station. The only difference is one of quantity of supply: that of the Cincinnati reservoir being 50,000,000 gallons and those for Kansas City 30,000,000 gallons.

The Cincinnati commission had for its president one of the gentlemen who later served on the Kansas City commission, Mr. Chas. Hermany, chief engineer of the Louisville Water Works. The other members were:

Henry Flad, President of the Board of Public Improvements of St. Louis, formerly Water Commissioner of that city, Chief Assistant Engineer of the St. Louis Bridge, and Colonel of Engineers on the staffs of Generals Grant and Sherman during the war;

A. Ftely, Consulting Engineer of the Aqueduct Commission of New York City, and on the Water Supply of Brooklyn and Albany, and formerly Resident Engineer of the Boston Water Board;

Chas. B. Brush, Chief Engineer of the Hackensack Water Co. (reorganized) of Hoboken, N. J., and Professor of Civil Engineering of the University of New York;

Dewitt C. Cregier, formerly Chief Engineer, City Engineer and Public Works Commissioner of Chicago. These positions representing a continuous service of thirty-three years.

The report of cost for the Cincinnati supply as estimated by the commission (composed of the foremost men of the times in water supply engineering) is given below, and opposite each item is set the amount estimated by the Kansas City commission for the same details:

	Cincinnati.	Kansas City.
Real estate, including right of way	$ 75,000	$.
Buildings at supply station	235,000	75,596.50
Intake-tower	100,000	66,500.00
Machinery and boilers at supply station	900,000	100,000.00
Settling reservoirs	1,350,000	303,000.00
Pipe lines to city distributing station	416,000	125,825.00
Tunneling river	400,000	117,434.00
Gate wells, stop gates, etc.	50,000	
Engineering and contingencies	401,200	
	$ 3,927,200	$ 796,356.50

Note.—From this table is omitted an item of $486.000, included in the Cincinnati report for piping to Eden park reservoir, since there is no necessity for a kindred expenditure at Kansas City.

The cost per million gallons, as estimated by the Cincinnati commission, is $78,545, and at that rate a plant and equipment for delivering Kansas City's supply to the city side of the river would be $2,356,350. If we assume as correct the cost for the remainder of the equipment necessary for a complete plant, $1,206,079, as estimated by the Kansas City commission, the whole work would cost $3,462,429. If, however, the same percentage of error extends to the Kansas City side of the river, the total cost would not vary materially from $6,000,000, and if the commission's figures are accepted, it is clear that the cost of land and reservoirs on the Kansas City side must be added.

Finally, in order to save expenditure, they have deliberately recommended a plant which is impracticable and dangerous. An appropriation of $2,000,000 for this work will be wholly inefficient, and when that amount is spent, no adequate water supply will have been obtained. (Signed) L. H. Gardner.

Opinion of Charles H. Myers, Consulting Engineer, and for Twenty-five Years an Engineer on the Public Works of New York City:

Gentlemen:—I have received the report of Messrs. Holman, Hermany and Benzenberg upon a new water supply for Kansas City, Mo.

In answering the question, "What system of water works is best adapted to Kansas City," these gentlemen say, "for distribution, the direct pressure system without any stand-pipe or reservoirs."

In this I differ from them, believing that it is better and safer to employ stand-pipes or reservoirs in connection with the direct pressure system, to provide against accidents.

The pressure proposed upon the new pipe system I consider inadvisable.

It is my opinion that if the works are built as proposed, the total cost will exceed the estimate of the engineers aforesaid to a considerable extent, exclusive of the cost of land, supervision, incidental expenses and contingencies.

(Signed[C. H. MYERS.

Opinion of Peter Milne, Consulting Engineer, and for Many Years Connected with the Brooklyn Water Supply.

I have made examination of the report of Messrs Holman, Hermany and Benzenberg, engineers, employed by the Board of Public Works of Kansas City, Mo., to determine a plan for the supply of water to that city.

In my judgment the estimates contained in the report are too low in price, particularly the proposed tunnel construction. This estimate is based upon official reports submitted by the Engineering Department of the city which, itself, assumes that certain conditions of foundation exist below the river bed. These conditions are simply assumed because of borings made on each side of the river. No positive information or data is shown to prove that the same conditions exist, and where most needed in the proposed construction, viz., the central area of the river bed. In the history of tunneling under the beds of rivers thus far, the most liberal estimates are meager figures for the actual cost.

According to the experience thus far on record concerning tunneling under the Detroit river and North river, it would be regarded as a safe estimate to multiply by five the estimate submitted, which would then be $603,420. The same line of argument can with reason be pursued regarding the cost of construction of foundations for pumping engines at settling basins. It will be found in result that sheeting, shoring and bracing, together with expenses of pumping, are very much in excess of the estimate.

All of the subdivisions of the estimated cost of the work are low in view of the con-

ditions to be met with. Many of the important items of the expense involved in the proposed plan are omitted, among them engineering expenses and contingencies, which are invariably associated and recognized in all public works estimate of cost. A serious omission is apparent in the fact of no calculation having been made for either reservoirs or standpipes, and still more serious, no supplementary main. The plan as proposed places the city water supply in jeopardy in the event of an accident occurring to the single discharge main from the pumps. No reserve of water is provided for, and no reference is made to such a requirement in the event of an emergency likely to occur at any time, and when least expected. The present reservoir is ignored. The typographical characteristics of Kansas City are such that a direct pumping system as proposed in the plan will, in the distribution system, of necessity create excessive pressure in the low level districts in order to obtain adequate pressure in the high level districts. This defect in distribution of pressure should be acknowledged by the engineers, and it is further remarked that provision should be made to equalize the pressure by introducing automatic devices to accomplish the object. No positive statement is, however, made to satisfy the engineering mind as to how an automatic pressure valve can be made that will adjust itself to the various degrees of pressure likely to ensue from direct pumping. Thus far in mechanical engineering practice, a constant factor of pressure must be sustained on one side of the valve in order to insure a fixed pressure upon the other. The enormous pressure proposed in the plan of the new works involves serious questions. Prominent among them is the ability of the plumbing work now in buildings being able to sustain it. I am of the opinion that the damage resulting from burst service pipes and hot water boilers, will practically amount in cost to the duplication of the entire plumbing work, as well as the inconvenience and loss of time incident to such a change, and particularly in the low districts.

The increased velocity thus created by increase of pressure will largely increase the waste of water, and, in the near future, will necessitate additional pumping power and water mains.

The bare suggestion of submitting a plan of new water supply, involving the complications herein stated, is calculated to create the impression that, however well disposed the board of engineers engaged by the city were to provide plans for new water works, they had failed to consider the result in detail so far as it relates to the question of expense to the water taker.

I am of the opinion that a better plan of distribution would be found in arranging it so as to obtain relatively moderate and practically equal pressure in all portions of the city, and without detriment or damage to the present house service distribution.

A reservoir system, where it is possible to obtain it, is always to be preferred to a direct pumping system; the pressure being constant, and the reservoir, if ample in area, provides a reserve which gives a security to the people not otherwise obtained in a direct pumping system.

In the event of a conflagration, a direct pumping plant is more liable to break down than at any other time. A reserve of water in a reservoir or reservoirs is not to be deprecated in connection with a water works system.

(Signed) PETER MILNE.

BROOKLYN, March 29th, '92.

THE PRESIDENT.—The paper is before us and we have still another one on the list for this morning's session.

Mr. Linneen moved that the discussion on Major Jones' paper be deferred until the afternoon session. Carried.

MR. JOHN C. KELLEY.—Mr. President, Before the meeting adjourns I wish to make an announcement in reference to the excursion on Saturday. We would like the gentlemen to notify the Secretary how many will attend on Saturday. I wish to say to the gentlemen from the East that if they desire it they can return to New York at 2:30 or 3 o'clock, and it will give them an opportunity to leave on the evening boat, or by train. It will take until six o'clock to participate in the entire trip. We would like to have the gentlemen inform the Secre-

tary as to how many will attend, so that they can get their tickets. It is necessary to know by to-morrow afternoon, so as to be able to have a biscuit and a piece of cheese to eat.

THE PRESIDENT.—I want to make another announcement. The members of the Executive Committee will please meet in room 226 immediately after adjournment. This is to formulate some action to be brought before the Convention in the matter of the World's Columbian Exposition. I would like to say, that, in addition to the public exhibit, there are a number of interesting private exhibits in different rooms in the hotel. A great many of the private exhibits are very interesting, and I think the men in charge of them will try to make it interesting for you.

MR. BRUSH.—I would like to make a short announcement in relation to the trip to-morrow morning. It will be an early trip, but I do not think it will be any the less enjoyable on that account. I will put up the following notice in the Secretary's room:

NOTICE.

Those desiring to join the party going to Weehawken, to inspect the Elevator and Water Works *Thursday morning*, should meet at the foot of West 42d street at 7:55 a. m. Leave the Hotel at 7:15 and take the Yellow Broadway cars or the Sixth Avenue Elevated Road to 42d street. Then take the 42d street cars to the Hudson river.

Ladies' are specially invited.

The party will return in time for the morning session.

CHARLES B. BUSH.

The Secretary made a further announcement in regard to traffic certificates, and urged all members to have this matter attended to at once. The Secretary also announced that he had on hand a number of solid gold badges, such as had been adopted by the Association, and would be pleased to supply members with the same at the rate of four dollars each.

The meeting then adjourned until 2:30 p. m.

SECOND DAY.

AFTERNOON SESSION, 2:40 p. m.

The President called the meeting to order at 2:40, p. m.

The Secretary presented the following applications for membership:

ACTIVE MEMBERSHIP.

W. D. H. Washington, Hydraulic Engineer.....New York.
Albert D. Cypher.....Peekskill, N. Y.
W. D. Pollard.....Pottsville, Pa.

ASSOCIATE MEMBERSHIP:

Dr. S. Leslie West.....Bound Brook, N. J.
Philip Eley.....Bayonne, N. J.

THE PRESIDENT.—Gentlemen, you have heard the names of the candidates; what is your pleasure?

Mr. Milne moved that the Secretary cast the ballot of the Association for the gentlemen named. Carried.

THE SECRETARY.—In accordance with the vote just passed I hereby cast the ballot of the Association in favor of the candidates named.

THE PRESIDENT.—The business before the house is the paper by Major Jones on "The Kansas City case." Does any gentlemen wish to make any remarks on the paper. If there is no discussion on that paper we will proceed to the next order of business—"Protection of Exposed Water Pipes Crossing Bridges," by Mr. S. E. Babcock.

Mr. Babcok read his paper, as follows:

PROTECTION OF EXPOSED WATER MAINS CROSSING BRIDGES, ETC.

BY STEPHEN E. BABCOCK.

Mr. President and Gentlemen of the American Water Works Association.

I think it will be generally conceded that frozen mains and services are one of the most annoying accompaniments of the winter months in our northern latitudes.

Adequate fire protection demands that frozen mains be put in order at once and at any expense.

The distribution system of mains in most all water works require that some, or many water courses, or rivers, be crossed, either underneath the bed or over bridges. Many under crossings are difficult of original construction, and sometimes uncertain as to permanency, while an overhead bridge crossing is always accessible if leaky, the defects are apparent at once, and are only liable to the one objection of freezing.

In designing the Little Falls Water Works system I found it necessary to make four crossings, three over water courses, (the largest one, the Mohawk River,) and one overhead railroad crossing. In all these cases an under crossing was entirely impracticable.

Desiring to use the best and most serviceable non-conducting material, I examined various works in which the subject of non-conducting materials is mentioned. I found that all the tests are based upon the radiation of heat from steam pipes, and not a single author gives any data upon natural temperatures in cold pipes. Steam means a vapor of water heated up to a normal or sensible temperature of 212 degrees, or the boiling point, and a surplus of about 966 degrees of latent heat, which freeing itself produces the desired heat or warmth through radiation from the pipes containing or transmitting the steam. This condition is entirely different from the case of a water main. Water in a main in winter is about the temperature of 50 degrees Fahrenheit, while the freezing point is 32 degrees. The water may be kept fluid so long as the temperature in the main does not fall below 36 or 38 degrees Fahrenheit. The temperature of steam being so high, all non-conducting materials used in connection with it must possess, in addition to the qualification of non-conducting properties, also an element of non-combustibility—while the non-combustible properties cut no figures with a water main. I found that Haswell, in the well known Mechanics and Engineer's Pocket Book, gives the relative non-conductibility of materials, based upon hair felt at 100, as follows:

Hair felt 100; mineral wool No. 1, 83.2; sawdust 68; mineral wool No. 2, 67.5; charcoal 63.2; pine wood 63.2; loam 55; lime, slacked, 48; asbestos 36.3; coal ashes 34.5; air space, 2 in., 13.6.

In volume 5 and 6 of the Proceedings of the American Society of Mechanical Engineers will be found a very elaborate paper on the subject of non-conducting coverings for steam pipes, prepared by Prof. John M. Ordway, Boston, Mass. He arranged the various materials in order of efficiency as follows: Fahr. heat units 1 sq. ft. 1 hr., Glazed Cotton Wadding, 47.6; Wool Wading, 81.; Slag Wool and Straw Board, 90.51.; Live Geese Feathers, 96.4; Hair Felt, 102.3; Calcined Magnesia, loose, 123.6; Cork Charcoal, 126.5; Pine Charcoal, 136.6; Washed Fossil Meal, loose, 145.1; Plaster of Paris, 309.4; Extremely Fine Sand, 317.5; Air Space, 479.9; Fibrous Asbestos, 489.8; Coarse Sand, 620.7; Fine Sand, 623.; Naked Pipe, 1555.10.

In the course of the discussion over Prof. Ordway's paper, Mr. E. D. Leavitt, Jr., then President of the society, stated that when he became connected with the Calument & Hecla mines in 1874 it was then the custom in carrying steam pipes under ground to excavate a trench, place the pipe and then shovel the dirt back; the condensation was enormous; the defect was remedied by applying a coating of Plaster of Paris and saw

dust, mixed in the proportions of one part Plaster of Paris to two parts of saw dust. The plaster and sawdust was mixed as you would ordinary mortar and put on 2½ inches thick; while the covering was wet the condensation was heavy, but when it once became dry the condensation was less than one per cent. of the former loss, being about 5 per cent. total loss by condensation. The idea was obtained from a boiler covering used at a fair of the Franklin Institute in 1865. Prof. Eggleston, School of Mines, Columbia College, also mentioned the fact about the bridge at Grenoble which was built in the year 1626, and was destroyed by fire in 1837, (an interval of 211 years), that all the iron surrounded by mortar was found to be intact and just as bright when taken out as it was when the bridge was built. On the contrary, that which was not so surrounded or where there was an air space was very much rusted.

These two facts struck me very forcibly as to a possibility of combining both, with a view of protecting water pipes from loss due to radiation of heat and oxidation, or rust. I at once conceived the idea that it was practical to whitewash over with Portland cement a water main laid in a shoal trench, then cover it with 3 to 4 inches of Plaster of Paris and sawdust, apply an outside thin coating of cement mortar, producing a covering, when dry, that would be a preservative to the iron, a good non-conductor of heat, and, what is very desirable, at a reasonable cost. This scheme did not strike me very favorably in cases where the pipe is entirely exposed; a bridge-crossing for instance.

The best non-conductors make a loss in any event, some more and some less. Prof. Ordway's tests show that cotton and wool wadding make the least loss, while an air space pure and simple, or asbestos, rank very low, not much better than sand. Asbestos is a mineral fibrous substance which when separated bears a close resemblance to cotton, or perhaps more nearly to silk fibre. Trace it back and we find it is simply aluminum or clay, but in a different form, and while possessing the property of being non-combustible, probably owes all its non-conducting properties to the confined air held between the fibres. The province of asbestos is simply to protect the more combustible materials, which are the real non-conductors, from being charred or destroyed. Prof. Ordway, in his paper, remarks in regard to asbestos: "Asbestos is commonly supposed to have a wonderful virtue in resisting heat, but there is really no magic power in the mineral fibre. It is a non-conductor only when it is in a light, downy condition and full of air. It was observed that in those cases in which asbestos paper is put between the pipe and hair felt, the asbestos fails to prevent the scorching of the hair. Incombustibility should not be confounded with non-conducting power. And then again, experiments Nos. 47 and 50 show that a wrapping of asbestos paper does not insulate so well as the same thickness of mere air. The popular confidence in asbestos partakes of the character of a superstition."

An air space pure and simple ranks low, due to mobility. Prof. Ordway says: "Air alone, as is shown by experiment No. 50 in the tables, transfers much heat when it can move about in a closed space. The usefulness of mere air spaces has been much overestimated, for they can rarely be placed so as to render much service. The air no doubt slides much more freely over smooth particles. It is not unlikely that the great difference between wool and asbestos is largely due to the smoothness of the soapy mineral fiber asbestos. It is hard to conceive of anything bet-

ter fitted to counteract the mobility of air than the irregular twists of flattened cotton fiber, the crinkles and scaliness of wool, the fringed edges of down filaments, or the feathered angles of snow-like crystals. When more and more organic fiber is crowded into a given space, the thickness of the stratum remaining the same, the transmissive power appears to be diminished till a certain limit is reached, beyond which there comes an increase. Probably, then, the mobility of the air has been brought to a minimum, and the proper conducting power of the fiber begins to act more decidedly."

The Prof. Ordway experiments show that we must look in the direction of cotton and wool fiber for the best non-conductors, but with water pipes it has seemed to me that we must go a step further. We must find some substance or substances in combination that will supply back again the increment of heat lost. With steam, the boiler supplies this. A water main is constantly losing some heat from the water with the very best non-conductor pure and simple, and the only ordinary remedy is a more free circulation to bring new particles of the water into the exposed pipe to be acted upon. Where the circulation is rapid and constant through the whole 24 hours, this plan, in connection with a good non-conductor, fills the bill.

Unfortunately, however, during the hours of the night there is usually very little legitimate consumption, and resort must be had to waste pipes to maintain rapid circulation during the night hours. This means a loss of water, and as it costs money to produce the water in the mains, it is also a financial loss.

The question of spontaneous combustion then suggests itself. Water pipes in the winter, or even at any time, are always at a low temperature, with a certain amount of moisture or sweat on the outside. Spontaneous combustion under these conditions will hardly, if ever, take place; in fact, it may be assumed never. Again, all chemical changes, even decay, which is a chemical change, produces heat, and I turned my enquiries in this direction. I found that at all the knitting mills there is a waste product called wool waste, being composed partly of wool and cotton fiber; that this waste, due to the process of manufacture, is partly saturated with oils, and when placed in a pile slowly generates heat and finally decays. The best grades are sold to the paper makers and lowest grades thrown away. The best grades vary in price from 1 to 2 cents per pound. This material, then, just fills the required conditions of being first; the best class of non-conductor of itself, and also having in combination a partial saturation of oil, which promotes decay, hence heat. I determined to use this material as a filling around the water pipes crossing the bridges and as wood laid with the fibers parallel, and in no case with the ends of the wood at an angle with the pipe, to prevent the mobility of air through the cells of the wood, is a very good non-conductor, as well as a cheap outside covering. I determined to make a box surrounding the pipe of 1½ inch plank, so constructed as to be 6 inches away from the pipe at any point. The top of the box I made roof-shape, with an outside top stringer of wood covering the joints of the roof boards on top. Where the side plank join together, I butted the ends and nailed an inside cleat or batten on to cover the air space. The pipe I rested on blocks of wood set about 4 feet apart, filled in the space in the box with the wool waste, tightly rammed in, protecting

the outside butts of the side and roof planks with strips of tin nailed close.

I also tapped in two, one half inch wastes, one on each end of the bridge, to be used in case of an excessive cold spell of weather. The bridge coverings have now run about 6 years, and with perfect success. I used the wastes the first years, but for two seasons past the waste was not opened, and even where there was a very small consumption the water has run free until late this spring, when one of the pipes on a bridge gave out. On examination I found that decay had progressed so far with the wool waste as to render it valueless for the purposes intended. This has taught me the additional lesson that five years is about the lifetime of the effective working of the wool waste non-conductor in connection with water mains.

I have also had another experience with wool waste as a non-conductor and generator of heat protecting water pipes. In the Little Falls WaterWorks System there are two series of pressure valves cutting down the pressure from 240 to 140 lbs. to the square inch. The valves are the Ross Pressure valve, which are essentially a balanced valve or piston with three working disks, and regulated by a small pressure valve, ¾ inch. In very cold weather if the ¾ pipe should freeze, or a thin film of ice form on the barrel of the valve, it would work badly. To prevent freezing, I placed the first valve set in a house and arranged for a fire during the winter. When it was found desirable, a second feed line was constructed from the Distribution Reservoir to town. This line was so located of necessity that it was impracticable, without a heavy expense, to place the valve in a house, but a well in the road was the best plan that could be adopted. As the bridges had then worked a year satisfactorily, I designed a well enclosing the pressure valve and determined to depend upon the wool waste covering the valves, in bulk, for protection, in lieu of a fire. This plan has worked satisfactorily to date. This valve has never frozen and when well has been opened in very cold weather the air inside has always been found warmer then the surrounding atmosphere. The wool waste I remove every spring, send it up to the distribution reservoir grounds and bring it back in the fall again, each year adding a little new waste. This scheme has been a perfect success. It is but fair to add that this well is connected to the sewer leading down the hill and it may be that a portion of the hot air comes from the sewer.

In conclusion, I feel safe in saying that for pipes laid under ground with a partial depth or protection of earth, the Calumet and Hecla mine plan of a protection of plaster of paris and sawdust, with the addition of a whitewash of cement on the pipe as also on the outside of the non-conductor is, in my judgment, the best and cheapest method of construction to provide against freezing, while for bridges or any above ground pipes, a wooden box filled with wool waste, which is partially saturated with oil, is by far the best protection of which I have any knowledge; it combines both the non-conduction and the slow generation of heat. I trust that my researches in this direction may be of service to other members of the American Water Works Association.

THE PRESIDENT—Is there any discussion on the paper?

MR. BRUSH—I would like to ask if there is not some danger in putting a covering around a water pipe of fire by spontaneous combustion; if fire does not some times take place ?

MR. BABCOCK—I think the temperature of the water in the pipe holds the temperature through your pipe so low that spontaneous combustion will not occur.

MR. BRUSH—What is the danger of its being set on fire by boys ?

MR. BABCOCK—Your non-conducting material is thoroughly encased in wood. It would be the same case if you put any other covering inside a good protector. It is covered with a wooden casing.

MR. BRUSH—Is there any danger from sparks of engines ?

MR. BABCOCK—No, sir; your wood casing will protect it. The inside covering is not exposed to the atmosphere. It is not exposed to the action of any outside element.

MR. BRUSH—How large were the pipes ?

MR. BABCOCK—One 12 inches; one 6 and one 4.

MR BRUSH—Did you find any difficulty with large pipes freezing ?

MR. BABCOCK—No, sir.

MR. BRUSH—I ask because I carried a number of pipes across bridges in exposed places, and in cold weather I never yet found any difficulty at all with pipes above eight inches.

MR. BABCOCK—Of course, you take a large size pipe, and the water will not freeze. It will form a film around the outside and leave six inches or more of cross section area, where the water will not be frozen, and the difficulty is not so great as with small pipes.

MR. BRUSH—You think there is no danger from spontaneous combustion ?

MR. BABCOOK—No, sir.

MR. DUNHAM—I wish to inquire about the length?

MR. BABCOCK—One bridge is 214 feet clear.

MR. DUNHAM—The size of the pipe?

MR. BABCOCK—Six inches.

MR. BRUSH—I would like to ask in regard to the case that has been spoken of, whether there was any trouble from vibration on the bridge. That, I think, is sometimes more serious than the question of freezing.

MR. BABCOCK—It is, undoubtedly, so; but still I do not raise that point in this paper. I raised simply the point of freezing. There is an expansion of iron, but it is assumed that you will take care of that by construction at the ends of the bridges; either by anchoring back or by a heavy bed of masonry to prevent any shoving back. The danger in vibration is in disturbing the lead joints, in working them until they become free and leak. That is a matter I did not go into. I simply went into the question of non-conducting material. I had no trouble in that direction. I have always anchored my pipes well back on both sides.

MR. NICHOLS—No trouble with leaks?

MR. BABCOCK—No, sir.

MR. BENZENBERG—As to temperature; how low a temperature has that pipe been subjected to?

MR. BABCOCK—I could not say, sir, but I presume we have about as cold weather at Little Falls as in other places.

MR. BENZENBERG—Do you have any more than we have at Milwaukee?

MR. BABCOCK—I think we can even you up on temperature. We have snow there when there is no other place in the State that has snow.

MR. PRIDDY—I have had a little experience with non-conductors. The best non-conductor we have found in laying our pipes under ground, not over bridges, is a good manure. Even after the heat is out it makes a good protection.

Mr. Babcock—For service pipe we use a pipe box with an air space and wool waste. We all know if you take a bale of wool waste and put it in a pile it will generate heat and produce combustion. If you take manure it will produce a lower state of combustion. I think wool waste is perhaps cleaner and better. I do not think with water mains there is any danger of spontaneous combustion.

Mr. Dunham—I notice the temperature of the water as given in your paper is about 50 degrees. I know of many cases in which the temperature during the winter months is down to 32 degrees. From what source is your supply taken?

Mr. Babcock—This water is from springs. Thirty-two is the freezing point. Water at about 38 is at its densest point, and sinks and expands, and at 32 freezes. The greatest density of water is 38. If the water gets below 36 you are pretty sure to have frozen mains. I assume water in mains will run from 40 to 50 degrees. I think some of our mains will run over 50.

Mr. Dunham—My recollection is that the point of maxium density is 39.10. I know that in many places the temperature of the water as it enters the mains is below 50; or even 35 or 34, so that with a thermometer that shows 32 in water containing ice, you will only get 32 in the water taken by the pumps.

Mr. Babcock—That may be true; but I think you will find that in a pipe buried five feet under ground you hardly reach as low as 32, or even 38.

Mr. Dunham—In some places the ground is frozen at points below where the mains receiving water at 32 degrees are laid, although they may be laid five or six feet deep.

Mr. Priddy—The water at our place runs as low as 32 or 34, and never gets above 50, even in summer.

Mr. Wagner—I have not had any experience with freezing, but it is clear to my mind that we all have a great deal of trouble with pipes crossing bridges, and as

this matter bears on the subject, I will give a little experience of my own. I think it will solve the problem as to freezing, and also overcome the question of vibration. From the location of our city it was necessary to cross the river twice. In the first instance we encountered a draw-bridge, this creating the necessity of submerging. We found it was not so expensive as we thought it would be. The pipe was laid 125 feet above the piers of the bridge. The distance between piers being 275 feet. I used the Ward Flexible jointed pipe in both cases. Diameter of pipe 8 inch, pressure 90 lbs. One of them was laid in 1886 and the other in 1889. The cost of one was $750, the other $900. I test them twice a year, and have never yet had any trouble. I think this plan is far superior to crossing bridges. I would say this, however, if there is any member of this Association who thinks of doing this, he had better undertake the job himself. I have in my room the profiles of the work as it went on, and will be pleased to show them to any one. I think it the simplest plan; and as far as the work is concerned, it has stood four years now. I think it is as economic as any other plan, and I am certain it will not freeze.

Mr. Babcock—That is very true, where you have not got any amount of rock to take out. At Little Falls, the Mohawk river has a regular rock bottom. When the ice goes out, it plows through to the bed of the river. It would be impossible to lay a main there that would stand. You could not anchor it anywhere. There is about eight feet of water at dead low tide, at the point where we cross on the bridge. I assume you do not have any such beds of rock to overcome. I have only written this paper to apply to cases where it is impracticable to cross under the river. There is no question, where you can cross under a river, that it is the best plan. I do not criticise that plan, but there are places where it is impracticable. It may be possible but it is impracticable.

Mr. Benrenberg—I may recite a little experience that we have had with a main crossing on a bridge over a river, connecting high banks. When the water works were originally constructed, the commission designed a bridge to carry a main across this river. It is a 30-inch main, and the bridge was made rather light, although it

was contemplated to carry some travel in addition to the dead weight of the pipe. The pipe has been incased with an insulated matched flooring, concentric with the shell of the pipe, with about four inch air space between. The air space was shut off entirely, and ribs were occasionly placed around the pipe to fasten the matched flooring to it. The pipe hung about forty-five feet above the water level, and as I said before, crossed a very deep ravine, where the wind had its full force during the winter time, when we never had upon the river less than two and a half up to four and a half feet of ice. No trouble was had at any time with freezing in the pipe. The casing remained until it became decayed and needed replacing. However, the travel across the bridge necessitated either the strengthening of the bridge or the taking of it down and replacing it with a stronger roadway bridge.

Another point which at the time was not particularly mentioned to the people—and which was a main point in changing the location of the pipe—was this. During the time of the labor troubles some six or seven years ago, it was hinted amongst some of the men that the water works of the city might be disabled by placing a little dynamite at that pipe. It was decided to take the pipe off the bridge, so as to lessen the load upon the bridge and to bury the main. The pipe was 556 feet in length. I placed the main down the bank, supported with trestles, etc., and buried it about five feet below the river bed, rising on the other side to make connection, and discontinued the use of the old pipe on the bridge, and later took it down. They have been using the old bridge since as a highway. We never, however, had any trouble with freezing in that pipe. There were times in cold weather when the flow in the pipe was reduced almost to a minimum, but the air space seemed to be sufficient; and even at the low temperature we occasionally have at Milwaukee—not of late years, but in former years—we have had no trouble at any time with freezing. However, I think I agree with the last speaker, that wherever it is possible even at additional expense, it is wiser to bury the pipe, and get it out of danger, of whatever kind it may be. Give it a permanent location, subject to no interference, either by vibration of bridges, freezing or anything else. In making the crossing no flexible joints, but rigid joints

were used. We never use flexible joints. The joints are made by divers, and we test the pipes once a year.

Mr. Babcock—I desire to state that where it is possible to make under-crossings it is far preferable; but occasionally there are cases where it is impracticable. The point I tried to urge in this paper was that introducing an element of heat, by the decay of some material, was the true plan to protect the water main from freezing. That is the essence of the whole paper.

Mr. Gardner—Mr. Benzenberg has stated that he tests his pipe once a year. I would like to ask how he does it.

Mr. Benzenberg—We have a valve at each end of the main rising from the river bottom. Connecting therewith, between the valves on each side, we have a connection to which we can attach a force pump and a pressure guage. We also have manhole connections on the down grade side of gate, so as to enter the pipe. The pipe is emptied by a waste-way near the water line. The gates are closed, the manholes are opened, and it is observed whether there is any leakage through the valve. Then on either side we fill up the main again, and put on an additional pressure of about fifty pounds, and by the pressure guage attached determine if there is any leak and to what extent. If there is only a seepage, but nothing that would indicate a leakage sufficient to cause a dropping off of the pressure with a very slow manipulation of a small hand force pump, we pay little or no attention to it. That is our method of testing. We do that on all our mains for self-protection. We have mains crossing the rivers at different points, and occasionally find that they need repairing here and there. At times the water in the lake has been very low, and vessels here and there have run against our pipe. I have adopted this method of testing once in a year—in the spring—to see whether the mains have been moved or not. Last year we had two mains broken in our river where sufficient precaution had not been taken in protecting them.

Mr. Babcock—How do you locate these leaks under ground?

MR. BENZENBERG—We engage a diver and have him follow up the pipe joint by joint, while a considerable pressure is maintained to force the water out. It cannot, however, always be located. We had a leak on a thirty-six inch main that bothered us considerably. The leak was not a very large one, but still it was a leak. We tried to locate it for nearly a week, but the diver could not place it all. We let the matter go, and finally tried it later on again, eight or nine months afterwards, and found that the leak had increased. We sent the diver down again, and he examined every joint. He went over the bottom of the river, and found no indication of water coming from a leak. It could not be discovered anywhere at the joints.

MR. BABCOCK—Was not that an expensive operation?

MR. BENZENBERG—Well, it was. We let the matter go until fall, and then the leak indicated itself upon the surface, and in making an examination it was found to be on the bottom of the pipe, and had gradually worn through the thirty-six inch pipe. It had cut a groove as large and like the shape of a finger. The reason it had not been discovered before was because the leak was on the bottom of the pipe.

MR. BABCOCK—How did you repair that leak?

MR. BENZENBERG—In this case I had two half sleeves cast that took in the entire part of the pipe that had been grooved out by the force of the water, thus reinforcing the pipe and at the same time making a sealed connection. The connection consisted of, you might call it, two hubs, as half sleeves, with the joint run over entire lead space in the hub beforehand, then the sleeves were parted and with a small lead joint in the sleeve, horizontally joined them by bolts securely around the pipe. The lead was quite soft and pressed down on the pipe. We have had no trouble with it since and cannot discover any leak in the pipe. We have had two such experiences. About a year ago the water was quite low, being carried out by the west wind, and one of the Lehigh line of steamers grounded on one of our pipes and broke a section nine feet in length: We knew of the break immediately by

the loss of pressure. We had had a little suspicion about this crossing anyhow, it being the first crossing that had ever been laid under our river. By shutting off this section we found that the break was at this particular point. Desiring to place this pipe sufficiently below the bottom, so that another similar accident could not occur in the future, I had a close survey of the pipe made clear across the river, and also of the inclination of the pipe where it passed through the dock. The pipes passed through at an angle, reaching the lowest point of the crossing about twelve feet beyond the face of the dock. A careful survey was made of the break and of the inclination, and then began to lower the pipe from the opposite shore. Having had a special casting made, consisting of a bend, the same was connected to the piece that passed through the dock, and connected the same with two half sleeves, in the same way as spoken of a little while ago, with the lowered end of the pipe, which had been cut beyond the bell. We have had no trouble with it since, and in a similar way repaired a small break in the middle of a pipe line at another point crossing the same river. These were the first two crossings put in. We did not at first guard sufficiently against such accidents by lowering the mains to the depth we now find necessary.

Mr. Babcock—You use divers in making these examinations; it is expensive, is it not?

Mr. Benzenberg—The repairing of this break caused by the Lehigh steamer cost us between $1,100 and $1,150. That included the expense of lowering the main, cost of special casting and of making the repairs.

Mr. Babcock—It is a good deal of money to spend to repair a break?

Mr. Benzenberg—That is true; but we could not put up a bridge without a greater expenditure.

Mr. Brush—The experiences given are very interesting to me, as I am sure they are to others. As I understand Mr. Benzenberg, it is this; that in order to repair breaks under the river, an ordinary cast sleeve is run with soft lead, cold, so as to make as near a perfect

fit as possible, and then bolted on over a leak or joint, and can be screwed tight, and can be got so as to make a practically tight joint on large pipes, say thirty-inch pipes.

Mr. Benzenberg—Yes, sir; that has been done. In order to make the joint in a half sleeve conform to the shape of the pipe, the pipe is very accurately calipered by the diver at the point of connection or contact with the half sleeve. We keep in stock continuously some of the pipes of various makers of all the sizes that we use. We select that pipe and run the joint in half sleeves, the half sleeves are put in place and bolted together, and the lead joint run as you do in a ditch. The lead joint is then sawed apart at the junction of the two half sleeves. In order to hold the lead in the hub small holes are drilled in the hub at the joint space about $\frac{3}{4}$ to $\frac{7}{8}$-inch in diameter. When the joint is run, the lead runs into these openings, and to a certain extent holds the lead joint. As I said before, the joint is cut at the junction of the two half sleeves, and the sleeves are taken off, and if they are close to the shape of the pipe they are ready to be permanently placed. After they are put in shape, the sleeves are placed and drawn up by tackle from above and bolted together. We put on the pressure and examine the gauge, and if a leak is discovered we take the pressure off and close the leak at the point by caulking, and keep doing so until there is no leak of any kind discovered. We do not find it a very difficult job, and a break in the main is not the horrible thing now-a-days that it used to be.

Mr. Brush—When a break is repaired in this way, you test the main, and I suppose you find the main is reasonably tight?

Mr. Benzenberg—There may possibly be a sweating or seepage through the joint. The test would indicate this in the course of time on the pressure gauge; but we do not take any account of this. Our mains are subjected to from fifty-five to eight pounds pressure.

Mr. Brush—In connection with this question of repairing mains under water we have had some exper-

ience on our works. We use the Ward joint. It works very satisfactory; so satisfactory, in fact, that we did not go to the expense that Mr. Benzenberg very wisely incurred in examining every year the mains. Suddenly we found we were without water. The result of the examination showed that the river had scowered so that the main hung as a chain at a given point in the channel. After the main had settled till, iron met iron, it suddenly parted. Since that time we began to use the method which our friend has recommended. The only remedy is to do as Mr. Benzenberg does, that is send a diver down and examine every pipe crossing at least once each year.

Mr. Babcock—I prefer an under crossing in any event; but there are many places where it is impracticable. I wrote this paper to convey the impression that is was possible to use a substance that would generate heat. I did not claim that it was better to make an over crossing as against an under crossing.

Mr. Dunham—Reference is made to one of those places where it would be extremely difficult to effect a lodgement of the pipe in the bottom. I have had a little experience in such a place. The distance across was about 1200 feet, and the water six or seven feet deep, bottom, rock, very hard, current swift and ice very bad. The 10-inch pipe was lowered to the bottom, and 2-inch holes drilled into the rock behind every second bell, and one and three-fourths inch bolts dropped into these holes and then on both sides of the pipes a considerable amount of riprap was deposited, and it has been in satisfactory condition every s nce.

Mr. Wanner—I expect the gentlemen who just spoke must have done some work on the Mississippi, where there is a hard rock bottom. In laying a pipe on the bottom of that river we found that the rock was not very smooth. It fortunately, hower, ran in ledges, and for about the first 120 feet out of 250 feet you may say that the pipe is wedged between the rock. I tried to protect the pipe by ripraping it on both sides. I have a consumption of only a few people, having about 800 taps. I think if any leak should start and increase to

any extent, I would surely notice it. I think it is pretty tight at present.

Mr. Priddy—I test my mains two or three times a year. Our ground is very porous; 50,000 gallons a day would not show on the surface. The way I test my mains is to take the water-phone, and test the hydrants and curb-cocks, and by that means I can nearly always locate the leak. The phone is very sensitive, and you can readily detect a leak.

Mr. Benzenberg—In the determination of leaks in mains on the street and in private service, I wish to add my voice to the fact that there is nothing better than the water-phone in such cases, but in crossing over the river it is difficult to tell with a phone just where the leak may be.

Mr. Espy—I desire to add just a word to what has already been said on the paper now before us for discussion.

The Company I represent (the Wilkes-Barre Water Co., of Wilkes-Barre, Pa.) laid two 18 inch pipes across the Susquehanna River, at a point near our city. They were both laid parallel, a few feet apart, and on the bed of the River, with no covering to protect them.

The pipes were used only in extreme dry weather, to pump from large wells into the main supply pipe.

About two years ago it became necessary to use them, when it was discovered that one of the lengths of pipe had been broken, evidently by the ice.

Pipes laid in the river, should therefore, be protected.

Last year we laid another, a 24 inch ward joint pipe across the same river, not far from the two 18 inch heretofore referred to. We first dredged a channel with a river dredging boat, about four feet deep, then with the same dredge, laid the pipe, and covered it. Since it was laid, it has not given us any trouble.

In order to compromise the matter and end this discussion, would it not be well to lay your pipe on a bridge where the river bed is rock, or to cover it in the bed of the river where it is not; or to have two lines of pipe one covered in the bed of the river and the other across a bridge.

MR. ALEXANDER—When we laid our construction lines in the Allegheny river about three years ago, we had, probably, six all told. Two weeks after we laid the pipe we had occasion to look for it, and found that some other fellow had laid a pipe across ours, and in another month another pipe was laid, and then another, so that they riprapped our pipe with pipe. This pipe is all wrought iron, and it is rare to see a leak in the pipe under that river. There are as many pipes in the river as in the streets. They are screwed up and dropped into the river, gas, water, oil and everything combined; and you have got to mark your pipe to know it when you want it.

The President announced the next order of business to be the paper by Mr. George W. Rafter. "On Some Circumstances which affect a Water Supply."

The Secretary read the paper as follows:

SOME OF THE CIRCUMSTANCES AFFECTING THE QUALITY OF A WATER SUPPLY.

BY GEORGE W. RAFTER.

(*Abstract.)

The paper begins by calling attention to the several sources of contamination to which water is subject on its way to the consumer. Ground waters dissolve mineral substances, rain water appropriates floating organic matter from the air, while surface water takes up a great variety of substances in its flow. Some of the foreign material which is appropriated in these different ways may be exceedingly deleterious, and a study of all the circumstances affecting the quality of a water would require to be broad enough to compass the whole question of water supplies from the sanitary point of view. The present paper is therefore limited to a consideration of the subject from the natural history point of view, a statement of the microscopical life found in the Hemlock lake water supply of the city of Rochester, being given by way of illustration.

Hemlock lake is twenty-eight miles from Rochester, in a deep narrow valley with bold, steep shores, the hills to either side rising to several hundred feet above the lake. The drainage area is about 26,000 acres, with 18,000 to 19,000 in cultivation. The geological formation of the bluffs is the Marcellus shale, into which the basin of the lake extends more than seventy feet.

A table is given embodying all the chemical analyses of this water

*The original copy of this paper, which included the tabulations, has unfortunately been lost. This abstract, substantialy as published at the time of reading, is therefore substituted by the author's permission as the best that can be done at this time.—SECRETARY.

which, so far as the writer knows, has thus far been made. This table shows that both albuminoid and free ammonia are quite low in this water, the largest quantities having been found by Professor A. R. Leeds in 1881, when 0.022 and 0.0015 were present respectively. Nitrates were present in 1881 to the amount of 0.63 parts for 100,000. Chlorine showed a trace only in 1877, 0.194 parts in 100,000 in 1881, and 0.34 as a maximum in 1889. Total hardness was 5.48 parts in 1881, total solids 9.99, mineral matter 3.99 and organic and volatile matter 6.00 parts for 100,000.

In regard to the chemical analyses it is stated that they were all made previous to 1890, while the quantitative determinations of microscopical life have been mostly made in 1891 and 1892. The chemical and microscopical analyses, while therefore not comparable in point of time, may be still both taken as confirming the view that this water is nominally of high organic purity.

The amount of life in even very pure water is now known to be large, which may be easily predicated when it is considered that the larger bodies of water are inevitably the final depository of the biological fauna of the entire tributary area.

Plant forms have been identified in Hemlock lake as follows: Chlorophyceæ 29, cyanophyceæ 15, desmidieæ 14 and diatomaceæ 41, making a total of plant of plant forms of 90. The maximum quantities of some of these minute plants per 100 cubic centimetres are: Protococcus 2,000; Anaæna 20,000; Cœlosphærium 34,000; Asterionello 40,000, Cyclotella 60,000; Fragillaria 25,000; Stephanodiscus 60,000. The total number of animal forms is given as 92, of which 3 are classified as spongidæ, 10 as rhizopoda, 29 as infusoria, 2 as hydroida, 14 as rotifera, 3 as polyzoa, 21 as entomostraca, 1 as malacostraca, and 10 as insect larvæ.

As to maximum quantities of animal forms observed we find among infusoria, Dinobryon 12,000, Glenodinium 25,000 and Vorticella 9,600.

In regard to the several species of plants and animals tabulated it is stated that while the quantitative microscopical determinations have all been made recently, the qualitative have extended over several years, the earliest having been made as long ago as 1876. The results represent in this particular the work of several observers, no person having yet seen every form tabulated. It is considered, however, that all the species referred to are present in this water, although a few of the rarer ones are still to be verified.

The quantitative examinations are hardly as complete as could be wished. It is only in the last three years that any method of enumeration at all has been available, and lack of time for work of this character has thus far prevented such systematic study as would result in a complete enumeration. The quantitative results given are the maximums from the examinations thus far made, which, as already stated, are mostly included in the last sixteen months. A number of forms, as, for instance, Volvox globator, which have been the cause of objectionable tastes and odors in former years, have not been seen since the quantitative examinations began.

A few interesting points have been worked out which have not been referred to by the writer in previous papers on this subject, as, for instance, it is found that Anabæna is present on the surface of the lake in

what is known as the agglutinated form in the spring and summer, and at the same time entirely absent from the distribution mains in the city. In the winter it is found in nearly equally large quantity in the distribution system and absent from the surface of the lake. The mouth of the supply conduit at the lake is about thirty feet below the low water level of the lake surface, whence it is concluded that while in winter this little plant takes to deep water, in warm weather, on the contrary, it prefers the light and warmth of the upper stratum. The observations thus far made show the quantity of this alga per unit of volume to be larger in summer than in winter. The amount recorded, however, of 20,000 per 100 cubic centimetres is from the distribution system in winter and represents single filaments each averaging about 0.0002 inches in diameter and from 0.02 to 0.1 inches in length.

In regard to the seasonal distribution it is stated to be still somewhat provisional. During the years in which the writer has been interested in the minute life in potable water relatively more opportunity for study of the question has existed in the winter than during the balance of the year, a fact which may possibly account for the assignment of some of the species to that season as their period of greatest development. The recurrence of certain forms in quantity at about the same time from year to year has, however, been noted often enough to indicate what may be termed a fixed periodicity of some of the microscopical life. But this cannot be affirmed of all the species; some of them have appeared once only in a series of years. Of such Volvox globator, which developed in large quantity in the fall of 1888, may be mentioned. Again other forms have been present from year to year in small quantity, but have developed in large quantity once during the period of observation. This is also especially pronounced in the case of the diatoms, Cocconema and Encyonema, which have been observed in small quantity in the spring and summer from year to year, but which developed in vast quantities in a few days in the spring of 1889.

The systematic studies of the water supplies of Massachusetts which have been made by the State board of health of the State, have shown that a knowledge of the minute life in detail is absolutely indispensable for a proper understanding of the sanitary qualities of a water supply. The magnificent discussions of all phases of the question which the Massachusetts board have published in the last few years demonstrate this proposition so thoroughly that it is unnecessary to offer any proof, other than that afforded by the Massachusetts work as published in the several reports. It may be taken as settled that a knowledge of the microscopical organisms will, in future, occupy a very important place in a systematic study of the sanitary value of a public water supply. The circumstances affecting the quality are found to be of wide range and the statement of the minute life of the Rochester supply, which is here presented, may be taken as showing one direction at any rate, in which the matter must be probed, in order to arrive at full knowledge of the detail.

This proposition is considerably enforced, when we study certain water supplies where the quantity of minute is far in excess of anything ordinarily occurring in Hemlock lake; and, as illustrative of a supply with what is apparently an abnormally large quantity of minute life constantly present, we may refer to the Ludlow reservoir at Springfield,

Mass., where the following maximum quantities per 100 cubic centimetres have been observed: of the diatoms, Asterionella and Melosira, 405600, in April, 1890; of the algae, Coelosphærium 157600 in August, 1889; Chlorococcus 322400 in October, 1889; of animal forms the infusorian Dipobryon showed 364400 per 100 cubic centimetres in February, 1890.

But even the large quantities of minute life found at Springfield are dwarfed into comparative insignificance by the results of a series of examinations of the water supply of Newport, R. I., as given by Dr. Drown, in a recent report, from which it appears that on August 31, 1891, there were present in Easton's pond, one of the sources of supply for Newport, the large number of grass-green algæ (Chlorophyceæ) of 677750 per 100 cubic centimetres; on September 11, 1891, there were found 927400; on October 8, the number had fallen to 675700, but subsequently again rose until the enormous maximum was attained on January 18, 1892, of 1,428,600 per 100 cubic centimetres. Diatoms were present on the same date to the amount of 200700 per 100 cubic centimetres, giving a total of diatoms and grass-green algæ of 1,629,300.

As correlated to the quantity and quality of the microscopical life the question of the food supply of the animal forms may be briefly discussed.

In reference to the food supplies of the protozoa and classes immediately higher in the scale it may be said:

1. That the chief food of fresh water sponge is largely the minute spores of algæ, although the sponge as growing attached to a fixed place cannot be considered as having much power of selecting, and may, therefore, at times, take into its organism animal food also. It apparently receives and digests anything which the flowing waters in which it is usually found may bring to it. The proof that algæ may be considered the chief food is derived principally from the fact that the sponge apparently prefers localities where algæ spores are more abundant than infusoria.

2. Rhizopods according to Professor Leidy, chiefly devour desmids, diatoms and other minute algæ; and many of the illustrations in his fresh water Rhizopods of North America show the little animals in the very act of ingesting the various forms of plants, which they apparently prefer. The recurrence of examples of this character leads to the conclusion that the Rhizopods, unlike the sponge, have some power of selection and are able to exercise a degree of preference. Some species of Rhizopods feed on infusoria and rotifers as well as desmids, diatoms, zoospores, etc., and among such Actinophrys, Actinospherium, and Acanthocystis may be mentioned as preferring a mixed diet.

3. The infusoria probably take whatever comes in their way. The movement of the flagela and cilia of the different classes set the water in the vicinity of each individual in motion and everything within reach, and not of too large size, to enter the oral aperature is received, digested and the refuse excreted the same as with other animals. Some species prefer decaying animal matter (Paramecium, Doleps, Vorticela, etc.,) and are usually found in vast quantity where such decay is taking place. Others (Brachelocerea, etc.,) are found among vegetable debris, filaments of decaying algæ, etc. Algæ spores are probably a large portion of the food of the infusoria the same as with the rhizopods.

4. In the next higher class of animals we find hydra, which is essentially a carnivorous feeder, worms, entomostraca and other animals falling an easy prey whenever they venture within reach of the moving tentacles.

5. Polyzoa feed mostly on desmids, etc., with decaying vegetable matter; they have a finger or tongue like organ stretching over the mouth, which seems to enable them to exercise some selection of the food coming within reach. They have been seen to swallow rotifers and probably take more or less animal food.

6. Rotifers are like infusoria in that the rotating apparatus from which they derive their name is in rapid motion when feeding, and brings into the capacious mouth which characterizes most of the species, what ever happens to be in the vicinity, although some power of selection may be observed. Rotifer vulgaris, the type of all the rotifers, is usually found feeding on decaying algæ, etc.

7. The entomostraca are largely carnivorous, a number of species preferring decaying animal matter.

The foregoing, while a very brief resume of this part of the subject, is sufficient to further indicate the considerable variety of circumstances which may materially affect the quality of a water supply, and still be entirely overlooked until the microscope is brought into the investigation.

PRESIDENT—You have heard the paper; are there any remarks?

MR. ESPY—I move that the paper be received and filed, and the thanks of the Association extended to the gentleman. Carried.

PROF. A. R. LEEDS—I think that the great amount of labor that this paper exhibits can only be appreciated by one who has to go over in detail the great number of organisms which the auther speaks of. The examination under the microscope, of the vast number of samples that must have been studied, upon which to base his conclusions, and the indentification of the species, often times require many hours of careful investigation. We have already a great deal of literature upon the general subject but it is these laborious studies which possess a new and original scientific value. For example many authors have pointed out the fact that one of the species alluded to, the cyclops, multiplies very rapidly in water containing sewage, and as they multiply they devour and finally destroy the sewage matter. This author has pointed out similar functions on the part of many other microscopic organisms, which up to the present time are less known. Similar detail work is the best service that

engineers could render in the study of the troubles affecting the particular water supplies under their charge. They would find also that the use of the microscope would afford them a vast deal of pleasure as well as most valuable information.

An aid which will facilitate work of this kind may be had by examining the reports of the Brookline water works, near Boston. Mr. Forbes has made it a personal matter to examine each day, nearly, the water in the reservoir and to take an account of the existing organisms, and has subjected to examination the organisms which at particular times was the cause of complaint by the water users. For example, he found at certain times that the infusorium called the uvella, in what was a moderate quantity, say 2000 in a cubic centimeter, gave a very disagreable taste and smell. At another time, in its absence, there was no complaint, while at the same time there existed in the water a very large number of other organisms principally the diatom known as asbenonella, and the water was drank with satisfaction. Mr. Forbes says if water engineers will only get a microscope, and put under the microscope the water which they have to supply, they will find it a source of immense entertainment and of great use. They take in certain kinds of food, and in this way are helping human beings that want to use the water. I merely make these remarks, feeling that it was scarcely just to the author, who has put on file a valuable paper, that the paper should be passed by without recognition. I have been engaged in connection with a standing committee of this Association to classify the same kind of data that this author has presented; and this paper will be of material value to the committee.

Mr. Espy—As I understand this article is to be published in our annual report, so that we will all have an opportunity of reading it and examining it carefully, I make a motion that a vote of thanks be extended to the gentleman for the able paper he has presented. Carried.

The paper by Mr. Wm. P. Mason, on "Case of Contamination of Water Supply with Sulphuric Acid," was then read, as follows:

CASE OF SULPHURIC ACID IN A WATER SUPPLY.

BY WILLIAM P. MASON.

It will be remembered that some years ago, about 1879, a portion of Boston's water supply was considered in great danger of contamination with sulphuric acid, owing to the burning down of chemical works situated upon one of the tributaries to Mystic Pond, whereby some fifty tons of oil of vitrol were washed into the stream. Mystic Pond is about eight miles below the site of the works, and mill ponds intervene. Marked acidity was noticed at varying points in the course of the stream and intervening ponds, but no trace remained by the time Mystic Pond itself was reached.

This instance has often been dwelt upon to show how thoroughly nature at times takes care of even the stable inorganic additions to surface waters, but, as a companion picture, permit me to cite a case in which purification was not nearly so rapid.

On November 18th, 1886, a cyclone struck the main building of a sulphuric acid establishment situated in Northern New York and caused several hundred carboys of oil of vitrol to escape into a neighboring pond of 150,000 gallons capacity.

Some sixty or seventy feet south of this pond, and upon a level ten feet lower, is another pond of about 450,000 gallons capacity, the water from which is used for boiler purposes by a large fertilizer manufactory. The ponds are separated by a heavy road-way embankment of say fifty feet in width. Undoubted violent corrosion of new boilers having taken place at the fertilizing establishment, an investigation was inaugurated, and as a result a suit for damages was begun.

Upon analysis made February 11th, 1887, nearly three months after the accident, the quantity of acid ($H_2 SO_4$) in the lower pond was found to be 385. parts per million of water, and, as was to have been expected, the action of such water on metals was most marked. The material through which percolation had taken place was partly shale and partly sandy soil, but, I think, principally shale. The outlet of this lower pond varied with the season, but averaged perhaps a foot or so in diameter.

On September 26th, 1887, the acidity at the outlet had fallen to zero, but in two trenches dug on the north side of the pond towards the acid works, the acidity showed 1083 and 772 parts per million respectively.

On March 29th, 1889, over two years after the accident, the water in the trenches above referred to indicated 363. parts of acid per million, and the pond itself had again become acid to the extent of 28. parts per million.

My examinations ended here, but another chemist made an examination on May 21st, 1889, and found an acidity in the pond of 1.23 per million.

Of course these ponds are, with their small outlets, very far from being running streams, and the amount of acid originally dumped into the upper one bore a large ratio to the contained water, but when we dwell upon the Mystic Pond instance, and find that it was a question of days only until the more immediate mill ponds freed themselves from contamination, we are impressed with the fact that nature cannot always

do her work with uniform speed, and that at times her powers may be seriously overtaxed. The ponds which we have been considering did not communicate, and the acidity of the lower one was caused entirely by infiltration through considerable shaley material. The variation in acidity was doubtless due to the disturbing influence of dry and rainy weather. What is most to be noted however, is the great length of time during which the acidity lasted.

On motion, the paper was received, and the thanks of the Association extended to the gentleman.

THE PRESIDENT—If there is no discussion on this paper, we will proceed to the next paper on our programme. It is by Mr. C. Monjeau—"A Few Simple Suggestions as to Water and Water Supplies; their use and abuse."

After Mr. Monjeau had read his paper for some time, and had read it nearly half through, there was an interruption.

MR. GARDNER—Has the gentleman completed his paper.

THE PRESIDENT—It is not completed.

MR. GARDNER—The gentleman must proceed and read his paper in full.

MR. JONES—I do not think he is half through.

MR. GARDNER—We will sit here until twelve o'clock, if necessary, and we will hear him through. It is a courtesy that we owe to a gentleman who prepares a paper.

MR. MONJEAU—I think it would be wiser to postpone it until to-morrow. I would most gladly yield the floor and resume at any other time you may say. I wish to finally ask your help to do our duty as citizens and as purveyors of water; and I would like to have your complete and unwearied hearing and attention.

MR. GARDNER—The next paper, I believe, is by Mr. Milne; and I move that we now adjourn, and that Mr. Milne's be put at the foot of the regular list for to-morrow morning, and that Mr. Monjeau resume the reading of his paper immediately after the opening of the ses-

sion to-morrow morning. I have consulted with Mr. Milne on the subject, and it is entirely agreeable to him.

THE PRESIDENT—The motion is that Mr. Milne's paper be put the third paper on the regular list for to-morrow morning, and that we resume the consideration of Mr. Monjeau's paper on the opening of the session. Carried.

THE PRESIDENT—Mr. Kelley wishes me to announce that those who intend to go on the excursion tendered by the National Meter Company on Saturday, will please do him the favor of notifying the clerk in the Secretary's Office at once.

THE PRESIDENT—We will now adjourn until ten o'clock to-morrow morning.

Adjourned.

THIRD DAY.

MORNING SESSION, 10:25 A. M.

Mr. Milne in the Chair.

The Chairman called the meeting to order at 10:25 A. M.

The Secretary presented the application for associate membership of the Meter Register Company, Chicago, Illinois.

Mr. Diven moved that the firm be elected to associate membership in the Association. Carried.

THE CHAIRMAN—We will now hear the completion of Mr. Monjeau's paper.

A FEW SIMPLE SUGGESTIONS AS TO WATER SUPPLIES AND THEIR USE AND ABUSE.

BY C. MONJEAU.

Mr. Thomas Edison, prying deep in chosen channel of most valuable research, arrived at the conclusion that "Every atom seems to be instinct with life." What other scientist is there, who communes closely with nature and has failed to arrive at a similar conclusion? Most emphatically may it be said of water that its every atom seems, and all its visible atoms are—instinct with life. Indeed, water is still a mystery as deep as electricity. And neither in itself seems much better understood now than when "darkness was upon the face of the deep, and the Spirit moved upon the face of the waters and said, 'Let there be a firmament in the midst of the waters (or gases), and let it divide the waters from the waters (or gases from the gases.) And the gathering together of the waters called He seas.' Water is still the abode of gods to some; of demons to others; of the happy realm of the Great Spirit to many, and to millions a most fruitful source of superstitions which reflect no credit on professed religions -or *re-ligations* to the all-wise creator of life. But who to-day can doubt that water is the language, or rather the medium of expression chosen by the all-mighty and inscrutable power which seems to govern the globe and the universe, much as the invisible sovereign in the brain does these bodies of ours? For instance, how is the exquisite texture of the lily woven? the blush of the rose fashioned? the point of the thorn sharpened? the soul-full, cheery tint of health painted on the cheek of trusting innocence? On the other hand, what builds up the clouds and hollows the oceans? How are the mountains brought forth? and the rock ribs of the earth so framed as to resist the pressure of planets a hundred or thousand times its weight? and have all efforts of man yet succeeded in interpreting the depth of meaning inscribed and enfirbred in his majestic muscle? his most wisely adjusted bones? the hiding of life in his leaping blood, and his mind within a brain and nerve-center shielded by a skull whose exquisite adaptableness all the science of engineering and architecture, from the first Pharoah to the last American, never equalled? Nay, more still. He would be most bold who, in the full enjoyment of all his senses, would dare assert that even the keenest and most delicate mental activity is not itself a result or office of water as direct as are the form and fragrance of the flower and the existence of moving creation.

But we are now to deal with water solely in its relation to the comfort, health and lives of the people, and consequent results, and only by way of simple suggestions.

The strongest light casts the deepest shadow. The clearer the facts the plainer the lesson they teach. Science which speaks Latin only, cannot be the most helpful to the people. Anything which is not of the people, by the people and for the people, is not American in spirit, nor is it readily accepted and put to active use in our land. The limit seems to be reached in our progress, when the researches of science's laboratories and the principles, practices and prayers of statesmen, churchmen, and the mental activities of the great body of the people must accord. Consistency is not alone a jewel, but a necessity of civilization, and all that that implies. To use science as monarchs do pomp, as means of

awing or shaming the people, and ridiculing or contrasting their inherit ed beliefs and conditions with those of exalted learning and govering power, is not the part of wisdom. To introduce its conclusions, however lofty and beneficent, through the sounds and signs by means of which the heathendom of nineteen conturies ago courted gods and curbed slaves, does not and cannot accord with the principles and progress of a democracy like ours. The bone, brain and brawn of our power—the people—the rightful ruling element in the republic—must be informed or this proud and most mighty empire must crumble back to desert and to waste. And due information can only reach the people's understanding through the tongue they speak. The most dangerous mistake of science is to soar and scintilate in signs and sounds, which do not reach and light up the deeper recesses of the general mind. Publishers appreciate this, and give scientific discussions a wide berth, or publish them at prices which the rich buy for their show libraries and professionals reach through public institutions. Hence, there is not growing that general thirst for the necessary knowledge and information which our sublimely simple form of government presupposes, and should have the full benefit of in the average voter. Warrior warship, and lung power blowing brain and age aside from leadership, are but the natural results of this condition of things. Those old scenes of gods and heroes on the one hand, and base, brutal slaves for worshipers and soldiers on the other, cannot be rehearsed here without corresponding ruin resulting to all that we hold most dear. In the latter days of imperial Rome, it became the custom to place a black slave on the same chariot with and to the rear of a hero being acorded the exceeding homage of a triumphal return into the capital city through a breach in the wall specially battered for the solemn occasion. The slave's duty, in that position, was to point at the pride-full object of acclaim with the index of his right hand, and call at measured intervals, in deep, tragic tones: "Remember that thou art a man! Remember that thou art a man!" Oh that we could, as a nation founded on trust in the justice of God and the brotherhood of man, establish the custom of having not a slave, but some angelic form of wisdom stand over every learned citizen, and every public servant at his task, and tenderly, soul-fully voice this claim of the republic and every brother man: "Remember that thou should'st write, speak and do for the people! Nor forget their birthright to rule!" It were wise to remember always that the world's knowledge, like man's statue, grows on from infancy toward fullest growth by degrees: and that, consequently the highest learning of to-day must shame that of yesterday, and is, in turn, but a step toward that of to-morrow. (That is why enthusiasts so often prove to be, not "mere dreamers," but advance heralds of a world's unfolding history.)

The time seems fully at hand when no wise or loyal American can undertake, carry on, or complete a task or thing without considering as his foremost object, the welfare of his fellow-citizens and of the republic. To persist in doing otherwise seems but to foster ultimate ruin. The Nemesis of just nature is now hardby in the tracks of all nations, and nothing but justice due from the learned and mighty to the people can stay her strides.

As intimated at the outset, only suggestions are intended in this paper, but suggestions which, from the standpoint of the writer, at least, seem most urgently to claim your careful attention. Untoward circum-

stances, such as the lateness at which the kind request to write this paper was received; a broken right arm; absence from my library and laboratory for the last four months, &c., have, much to my regret, prevented the embodiment of many facts, statistics, and the exactness of statement and disposal of matter which the treatment of so important a subject requires.

It is now unquestionably evinced by science and practice that pure, wholesome water is the prime essential of health. Hence, it follows that such water is the prime essential to happiness which, in turn, is the foremost object of civilization, learning, labor, religion, art, government and war. Think, then, what tremendous responsibility rests upon this great body of suppliers of water to the people of this North American continent! No State, no National Congress or Parliament has as yet been burthened with a task of such vast and deep reaching interests. If the people were properly informed, if they but knew the haunts and breeding places of certain deadly epidemic and other water-bred diseases which, every five minutes, in this land alone, rend heart from heart, and dash highest hopes to the deepest depths of despair; if they but knew that 60 or more per cent. of all their bodily ailments are caused by bad water; if the nation realized that, simply through neglect of proper attention to the quality of water the people and their animals drink, it is wasting in human life alone, estimated simply at railroad valuation, not less than $1,000 per minute; $60,000 per hour; $1,440,000 per day; $10,108,000 per week; $43,420,000 per month, and $521,040,000 per year, irrespective of the wide-spread suffering and sorrow such loss implies, this association would, probably, be promoted to the dignity and power it should rise to and hold with as keen sense of patriotic duty as ever war was waged.

If I rightly understand the objective purpose of this association, it is not merely mutual improvement in the arts and economies of supplying the public with such water as happens to be at hand, without regard to its qualities, but also the promotion of the best possible treatment of water for its healthful use. If this understanding be correct, the first claims upon the best efforts of the scientific and mechanical skill of this far-reaching body are:

First—Water Supplies—whence and how to be procured and served.

Second—The urgent need of immediate united efforts to protect all concerned from careless selfishness, and other types of dangerous ignorance.

Supplies of pure ground water (by which is here meant water free from injurious components) served direct are usually more satisfactory than others, because such supplies, except in rock oil and mineral countries, are, as a rule, of more palatable, quenching and nutritious qualities than rock and surface supplies. It appears that the sooner after pumping ground and rock waters are used, the better. This is especially true of ground water.

It also appears that, for best results, it should not be at all exposed to light or atmospheric warmth, else the innumerable kinds and sorts of excessively small vegetable seeds or germs that seem largely to constitute ground water, transform very quickly in atmospheric warmth, and correspondingly change the character of otherwise good, wholesome water. Hence, it appears that if reservoirs of any description are used, it is es-

sential that they be as light-tight and air-tight and cool as the underground source of supply itself.

There is much underground water which is objectionable though not impure. In much of Indiana and Kentucky, for instance, spring and well water is so strongly charged with lime as to seriously discomfort people and stock of both sexes with gravel of enormous proportions. In the little Miami valley, and from wells in what is known as the "second bottom" of the Big Miami, experiments of ten years duration have convinced me that the lime in the water is of such active nature that it is naturally impossible to maintain a fine bone strain of animals, the bones developing considerably in relative size with every succeeding generation to the fourth and fifth. This bone is of remarkably fine and firm texture, quite the reverse of what results from the use of water charged with the magnesian, porous, spongy lime stone of Kansas and Southern Nebraska. Unquestionably the great bone strength of Kentucky, Ohio and Indiana horses is largely the result of the character and quantity of the lime in the water they drink.

Other minerals render ground water unfit for either house, farm or even mechanical uses. Such, for instance, is salt, as along the Smoky-Hill's otherwise attractive valley; and salt, iron and some sulphuric acid in many spots of the famous Kaw valley. Similar conditions appear in some 300 miles of the Missouri; though its original or canyon bed affords a liberal supply of water not yet tainted, and very agreeable to taste and touch. The lateral moraine, however, is often found too strongly impregnated with iron, and particularly after the cessation of the influnnce of the Big Sioux river, and the peculiar debris it once brought from the mountains and the ledges which are known as Sioux Falls granite, but which are, in fact, ferrugenous or rose quartzite, occasionally showing a trace of gold in iron. The grinding quality of this rock is good, and it has a corresponding effect on the fining of coursing water. The Mississippi Valley's ground water supply contains too much iron at many places to allow it to be stored above ground with impunity before consumption. It should be served to consumers, if at all, directly as it is pumped. This seems to be more or less the case (and rather more perhaps) all the way from the Twin Cities to the Gulf. From Paducah to New Orleans, where three considerable and distinct layers of water bearing sands are found below the gravel bed into which the surface water largely percolates, the lowest, which seems at an average depth of about 400 feet, contains the least iron and lime, and is, perhaps, when drank fresh from the flowing well or the acting pump, as good tasting, clear and wholesome water as this continent affords. If left still and exposed to air for a few hours, a chemical action takes place, which renders that splendid water unpleasant to the senses at least.

All ground water, it is to be profoundly regretted, is rapidly becoming more or less unfit for drinking purposes, owing to the corresponding increase of population and acts of most deplorable selfishness. I allude to that horrible means of clandestine murder practiced by directly sewering homes, public buildings, towns and cities into the underground sources of water supply. Unerring nature carefully covers these reservoirs of the prime essential of health and life with a genial soil, myriads of thriving shrubs, grasses and insects that reconvert all decaying matter into active life for the aid and support of more life. Besides, she has spread, super-

posed and compressed substantial beds of clay, packed with neutralizing alumina, which, if undisturbed and not overtaxed, allow no living germ of animal disease to pass unreversed or neutralized. But the average citizen, a speck upon this speck of the universe, despite these hints and guards set there by eternal wisdom, proceeds to punch, bore, or dig through them all and pour in the seeds of disease, death and desolation that must inevitably follow. What is the result? I will let the chief of this great city's Board of Health answer. Needless to add that I allude to Doctor Cyrus Edson. He says: "During the past year I have visited twenty towns supplied by water from dug and driven wells. In every instance the supply was polluted, and in the case of twelve was responsible for an outbreak of typhoid. The other eight were wanting only an initial case to infect the water supply and cause an epidemic." Are not such figures, coming from such a source, terrifically appalling? But listen further to that same great and trustworthy authority: "Typhoid fever is most frequently promulgated by contaminated well water. It is safe to say, that scarcely a well exists in this country the water from which is safe to drink." Are you prepared to give heed to such testimony? But if that be true of the country, where wells are estimated to be not less than a thousand feet apart on the average, (and I cannot ground the remotest doubt that it is true, and in the very nature of things must be,) I ask you, what must be the condition of village and city wells? And what reason for the existence of such wells can there be except intolerable ignorance or criminal recklessness reveling in ruin whilst the authorities at Washington and at every State Capital are absorbed with interests which are as mere nothingness when compared to these things, which on all hands imperil the health and lives of the people?

Perhaps it is better to assume that it is only ignorance, as is the case with most other crimes, and that, therefore, it becomes the duty of more intelligent citizens in that regard to urge these things upon the attention of Congress and local governments.

The Federal government seems the first party in interest; but it has given that particular matter but little if any thought, mainly because, I fully believe, it has not been brought to its attention.

Whatever our respective political affiliations, we all gratefully recognize in our Chief Executive a man of unquestioned integrity and uprightness, and a man thoroughly inspired by a firm and full desire to render the best service he can to *all* the people in all sections of our vast domain. There can be no question that, upon due presentation of this interest to him, he would at once recognize the absolute and general need of pure water as a protection against, instead of impure water as an invitation to, disease and death. As for Congress, all parties are represented there, and though all can boast many expert riders of many questions and fences, the people can usually depend upon the Legislative branch of the Government for the faithful and just protection of interests that are properly submitted. I have not the least doubt that Congress would promptly attend to a claim which involves the highest interest of all the people in all parts of the country. Let it but appreciate that due protection of our people from the present unguarded use of bad water would save to the nation every year as much as is required annually to meet the ordinary expenses of the Government, and you may rest assured that Congress will most promptly and effectively respond. So much for the dollar side of the proposition.

As a humane proposition, it is the most urgent claim upon public sympathy and efforts toward betterment ever brought to the intelligence of man. Horribly harrowing to the general sense of pity as is the Russian famine, it is but as the smile-mingled sobbings of a babe to the flesh and bone sundering torment of aged Job when compared with the dread desolation and sorrow resulting annually from the suffering, death and burial of at least a hundred thousand of the choicest young manhood, womanhood, youth and childhood of a people like ours. No field of battle, no war, from the siege of Jerusalem to the fall of Paris, has caused more widespread sorrow and waste than the neglect of proper attention to the water our people and their animals drink. Once more listen to the learned, experienced and trusted Doctor Edson. His words, compared to mine, are as finest gold to crudest lead. Yet he has thought and said precisely what I desire to convey to your judgment. Hear him: "In this and other civilized countries, laws are enacted for the purpose of protecting the community from the accidental and criminal use of poisons. Yet, while wise law-makers have recognized the necessity for restricting the distribution of those deadly but useful substances produced by man from the universal mineral and vegetable kingdoms, they have not recognized the thousand-fold greater necessity for restricting the distribution, by means of polluted well water, of the more deadly and useless poison which causes typhoid fever. Nothing is more discreditable to the civilization of the nineteenth century than the existence of typhoid fever. Wherever men are congregated in houses and villages, typhoid fever is epidemic. From Greenland to India, from England to China, it holds sway. Yet of all diseases, it is the most easily preventable, scarcely excepting small-pox.

Careful scientists have isolated its germ and taught us its characteristics. Numerous observers have shown us under what conditions the germ is best propagated, under what circumstances it perishes, and what agents best effect its destruction, yet their teachings seem utterly lost upon mankind, for people go on year after year drinking polluted water and spreading disease."

Doctor Edson, when stating these cogent facts, and others before quoted, was contributing a popular paper to the *Medical Record* on typhoid fever alone. It is not amiss to add just here, that the same facts and statements likewise apply more or less closely to diptheria, malarial fever, and diarrhœal diseases. Of typhoid alone, as shown by the last census, we lose over 27,000 of population every year—a number greater than our standing army.

Taking all these things into consideration, it may be the more fully appreciated how horrifyingly dangerous is the general habit of voiding refuse down one hole in the earth and drinking it through another. For my part I dare not attempt to characterize it. All language and history, outside of the Canadian bear, fail to suggest any suitable adjective or analogy. But it would require a large volume to properly set forth this habit alone.

I must hasten to touch up

SURFACE SUPPLIES,

which, it is generally known and conceded, are, of necessity, no purer than those from the ground, because,

First—It is self-evident that all sewage exposed on the surface of the ground endangers the purity of springs and streams, and all liquids liberated on the ground, barring the effects of percolation, absorbtion and evaporation, must flow into the surface sources of water supply. The consequences are as inevitable as natural, and as natural as inevitable.

Second—It is likewise self-evident, and demonstrated by innumerable tests and analyses on both continents, that germs of various water-promulgated diseases, such as typhoid, malarial, diptheria, &c., live and multiply in rivers, brooks, lakes and ponds, almost as freely (though, as a rule, not so virulently, so to speak) as in sewers, cesspools, milk, contaminated meats, moist decaying soils and woods, and so on. Therefore, surface water supplies, unpurified, are not safe and should not be allowed to be served or sold to the people for drinking purposes at least. Surgeon Smart, of the U. S. Army, in his Concord (N. H.) paper to the American Public Health Association (see p. 257, vol. XIII of official reports) inadvertently did you the favor of summarizing, with all the weight of his broad learning, long practice and masterly command of his calling and language, precisely the conclusion suited to these self-evident facts. He most plainly and conclusively says: "Bringing these considerations to bear on the sewage pollution of rivers and other large bodies of fresh water, your committee is inclined to the belief that the failure of the chemical process to detect minute traces of the contaminating matter is of no practical importance. For protection and prevention purposes the knowledge that sewage entered the water seems all that is required.

The sewage, if not infected at one time, may become infected at another, and is therefore an ever-present impending danger to the health and lives of the consumers. But when the constant and extensive prevalence of typhoid fever is taken into consideration, with the vast numbers of the contributors to the sewage outflow of a large city, the sewers of that city cannot be safely assumed to be uninfected. Hence, the sewage of a city entering a river above the point suggested as the intake for the water-supply of another community, should suffice to disprove of all such suggestions, irrespective of chemical analysis or any other considerations. As the well-water may become freed from the ordinary organic matter of sewage during its percolation through the soil, so the running water may have its ordinary sewage matter destroyed by a retroversion of its elements to inorganic forms; but there is evidence to show—the Plymouth epidemic for example—that this purifying influence cannot be relied upon to protect from specific infection. Nor can reliance be placed on the dilution which takes place in a large stream. Recent experiments on the causative essential of typhoid fever point to matter in particulate form as the element of danger. Dilution does not dissolve and dissipate into inocuity, as the typhus miasm is dissipated by ventillation. IT IS THERE, and although one tumblerful may not contain it, another may."

Unquestionably, the germ of disease and death "*is there*," and proves its deadly presence most expensively and tragically not less than 100,000 times every twelve months, and conditions are daily growing worse.

Pardon me if I venture here to apparently step out of the path ex-

actly marked by the subject in hand. But we all dearly love this land of ours. There probably is not one of us who, if overtly challenged, would yield his sovereign right to it except through death. Indeed, many of us here, now meeting as brothers, already have faced one another amid hurricanes of fire, steel, lead and blood, in order to save entire this home which the fathers framed for us all, and consecrated to God and the pursuit of liberty and happiness. Not that we loved one another less, but the old home more. And to-day, my brother of the South is as near to my heart as my brother of the North. We are *one* household. One and inseparable! Save just and laudable State pride, all our interests are one. And our home has four front doors—one South, one North, one East, one West. And not one of them opens outward. All open inward. We admit hundreds of thousands of new candidates for citizenship or brotherhood every year. All people born for untold generations to other and vastly different forms of government, and different manners, customs, habits and religious rites; and it is no secret that large numbers of them are ex-convicts. For reasons plain and simple, they multiply or increase, it is estimated, at an average of about 4¾ to the couple. The death rate among their issue appears to be but a trifle more than that among the young of the original stock. Meantime the old stock increases at the rate of about one and three-quarters to the couple. In other words, the ratio of increase appears to be about 4 to 1 in favor of foreignizing. Such facts need no comment. But here is the one fact this digression is intended to fix the more indelibly in your minds. Typhoid fever, and other diseases resulting mainly from the use of bad water, seem much more largely to attack and destroy the offspring of the original stock and of the home born. As loyal citizens and members of such an association as this, do not such facts suggest and urge the need of immediate improvement? We hear it said, and see printed, that "such matters are for the Government to see to." That is true on the one side of the ocean. Not here. Here, "*we*, the people," are the sovereigns. *We* are the governing power. It is *our* duty and obligation to direct our servants and indicate to them what we need for the highest welfare of the greatest number, and the perpetuation of this most glorious heritage.

But I may tax your patience at a more opportune moment with suggestions as to this duty.

Returning to our subject: We have seen that it seems quite just and safe to insist that surface water, unpurified, is, as a rule, no more safe than well water for drinking purposes. Because—

First—Surface drainage is, if anything, more apt to carry disease germs greater distances, and of a more virulent character, than sewage percolating under ground. On this particular point the instructive experience of Doctor John H. Girdner, a leading physician of this city, whilst on a visit in South Carolina, is of great value. Dr. Girdner, together with a local practicioner, there, directly and most clearly traced and proved the cause of a typhoid epidemic in a town to be from the stools of a patient on a distant farm, thrown out in a stubble field, to a crystal-clear spring issuing from a ledge, and which constituted the water supply of the entire community, but still was beyond the reach of contamination from privy-vaults and usual means of surface sewage.

The Plymouth, Pa., epidemic affords another like case. There it was shown that some 1300 persons developed typhoid from infection by the typhoid poison from one individual who resided on the bank of a small mountain stream from which the town was supplied with water.

The Swiss experiments; the impregnation of vast areas of lakes and streams with typhoid and other disease germs, as so often shown during the past decade by eminent experts on both continents, and more recently (in the colder regions, where it was supposed cold was an infallible disinfectant) by the scholarly Prof. MacFarlane, Chief Analyst of Canada; the Lawrence experiments, so carefully and ably conducted by the Massachusetts' State Board of Health, and scores of other cases too sadly familiar to many of us, seem to have established this fact beyond all occasion for doubt.

Second—Most all public and private sewers empty into or toward adjacent streams and other surface sources of supply.

Third—There is very seldom a day when a town or city of five or more thousand inhabitants is entirely free from a case or cases of some kind of epidemic disease impartable through sewage and water.

Fourth—There is equally seldom a considerable valley or water-shed, or a farming community free from such disease, so that every considerable rain or thawing snow may pollute the purest surface water supply and make it a means of discomfort and death, instead of health and happiness, any moment.

The most thorough process of mechanical precipitation known to me frees its water of only about 50 per cent. of its dangerous animal matter, and that, too, water of the Missouri River, which seems to precipitate the quickest of any in North America.

The clearer flowing stream water becomes, as a rule, the less animal matter it contains. It seems to be the reverse with ground water, and especially as regards vegetable germs and grave yard sewage. Precipitation can and does only carry impurities to the bottom, where germs breed on, or pass on from stage to stage of their respective destinies. What typhoid germs develop from and into, I have so far been unable to ascertain, and would be very grateful to any of you for experience on that most practical question. The germ of that class of influenza, called *la grippe*, I am almost convinced, develops, under given conditions, into something like the germ and effect of consumption (or PHTHYSIS PULMONARIS). Yet, strange as it may appear, it seems to attack and consume other parts as well as the lungs. It would be of incalculable advantage if the successive stages of existence through which these infinitissimally small creatures develop, could be definitely ascertained, for then they might be sterilized before passing into their condition or stage destructive to human life, as is done with the eggs of destructive insects, &c.

There is no telling when disease germs may be present in a water supply that is unpurified.

Mere filteration no longer suffices.

Since it appears that pressure sand-filters, and even Pasteur-Chamberlain filters, pass considerable quanties of various disease germs, and that the numbers passed increase with the ratio of pressure applied, it is plain that there can be no safety in the use of either surface or ground water which is not first properly treated and then filtered.

Water thus prepared will, of course, cost more than the poisonous product of the average well or stream untreated. But cost it must, except we are resolved on committing suicide.

A bar of iron worth $5 worked into horseshoes is worth $10; made into needles is worth $350; made into penknife blades it is worth $3,285; made into balance springs of watches it is worth $250,000.

Let the same ratio of cost of labor apply to water as well. Why not? Pure water and health at most any cost were cheaper than sickness and death in water at two to twelve dollars a year. The more intelligent and costly the work spent in treating a water supply, the more security it will afford, and the more money it must be worth and should bring. Pure water is the essential of essentials, and honest pay it should promptly command.

Ground water and surface water supplies being no longer safe, unless first purified and then filtered, except in isolated places, it follows that proper regard for public health and human life demand prompt and intelligent action through the channels provided under our form of Government.

PROPER SEWERING NECESSARY.

A gross evil forces itself upon our notice at this juncture, and one most dangerously neglected, even by several large cities throughout this country and continent. It is improper sewering. As before indicated in this writing, most of the sewering done so far has been done in such a manner as to largely pollute and poison both the ground and the surface sources of water supply. And there end, with very few exceptions, all efforts at intelligent, economical, safe sewering. What a record for the most inventive, intelligent, generally educated, refined people on this earth! What an abuse of God's gift of freedom, for individuals, towns and cities to use it to poison one another for the sake of pecuniary gain! Would any sanitarian inspecting the sewering and the lack thereof throughout these United States, and allowed to see no other evidence of our thrift and progress—even dream that we boast of recording more patents every year than all other peoples of the globe together? Should yellow fever, or typhus, or Asiatic cholera seasonably leap to these shores and gain a foot-hold, what power on earth could stay its harvest of death? when even cities of 10, 15, 20, 30, and over 50,000 souls reek with the miasm and poisons of back-yard cess-pools and surface sewers, which empty into the water courses from which the people are re-supplied.

Of course there is more or less excuse for this, besides greed and avarice bolstered by a class of voters already referred to. It is not long since fine-spun dreams concerning the self-purification of streams as they flow, obtained. In fact they seem still to obtain with many, or something worse if we may judge from devices now constructing. But such dreams answered the objections of a bygone age. Fixed to the center of the present, with the light of to-day's science dashed through them, they prove to be but "words, words, words!" Test for yourselves. Pour constantly an eight foot stream of black ink from the center of Brooklyn bridge into the stream that flows under it. Will that stream purify itself of that blackness so long as you keep pouring? Impossible. Ink will dilute, as alcohol does, exactly according to mathematical pro-

portions. Mayhap in water, mayhap in sand, mayhap in silt on the stream's bed. And there it must remain, as does the diluted sulphuric acid, iron, lead, zinc, arsenic, which poison multitudes of ground water supplies throughout this continent in the primitive river beds, and many mountain streams. Positive proof of the fact that streams do not and cannot purify themselves of what is being incessantly poured into them is set before you at least a score of times every spring and summer. When a sufficient rain falls to wash the plowed ground, or the cuttings of ravines into thin mud that colors your home stream, do you ever see that stream "clear up" till the mud ceases to come into it? Never. It is not in the nature of things.

Again, several millions of dollars are appropriated by Congress to clear the Missouri of snags and sand bars; fix its banks, redig its channel and make it navigable. Another dream of a bygone age, and one which will secure to future generations one more monument to our brain-crazing wealth or wanton waste. But what would be the use of thus trying to clear and reshape that river in order to regain the facilities of navigation it once afforded, if streams clear themselves as they flow? The former broad bed of that once mighty and majestic Missouri was deep enough for 10 to 100 rivers of the size of the present stream. But it is now almost wholly filled with silt, slush, fine sands, with which the prairie winds sport as does Boreas with Canadian snows. Pebbles, clay and coarser sands constitute the rest of the enormous deposit of what? Of the sewage or debris of the mountains, forests and plains beyond. The freed water has gone in vapor. Have the characteristics of these decaying remains disappeared? Not yet. Instantly, from South Dakota to the Mississippi and the Gulf, you recognize the separate particles of the rocks of the Dakotas, the ores, agates and granite of Wyoming and Montana. And the fevers contracted by diggers in Missouri and Mississippi mud and slush are not among the least distressing and deadly. Indeed, those deposits forcibly suggest a retention of power requisite to breeding disease quite as strong, distinct and energetic as the vegetable life in seeds of wheat and corn, which Prof. Lepsius found in the hoary pyramids of Cheop, and whose fruition is now felt throughout Christendom after a burial of some 3,000 years.

Of course it cannot be denied that living creatures in streams, as in air and ocean, feed on, and thus revive dead and decaying matter, which is, in fact, a very good, but also very limited process of purification. On the other hand, all aquatic life breeds; and much of it very rapidly. And that seems especially the case with the disease germs under discussion. It is held that over two hundred thousand have been counted in a cubic inch of water, so that the fact that the different kinds prey upon one another only argues a chance for the survival of the fittest, which can simply mean that the stronger the germ the more copious the harvest, or dangerous the disease it develops.

Briefly, it appears unquestionably demonstrated by facts of science and practice that, for the highest welfare of the greatest number, all sewage should be separated and the solids either cremated or safely put to economical uses, and the liquids neutralized and filtered before liberated. And thus, once more, it appears that the Government should be duly informed, and means devised and executed to meet this most urgent public want.

There now is before Congress a bill "providing for the protection of the forests of the United States." And that is a praiseworthy purpose. The only difficulty about it is, that it should have been framed fully 20 years ago. Still, it is better now than never. Rich, thrifty forests are a great boon to a country of the vast climatic variety of ours. But what are spacious, thrifty forests to a people's health and happiness as compared with springs, wells, lakes, brooks and rivers of pure, clear, wholesome water? Truly, as felt Byron on the dusty, parched, alkali plains of the East,

"Till taught by pain,
Men really know not what good water's worth."

The health of horses, cattle, sheep, swine, is extensively protected by means of Congressional appropriations. And that is well. More liberal appropriations would be better still. The moral health of citizens is also carefully looked after at Government expense. Why should the life and the physical health of the people go unprotected? Indeed, be left exposed to the most deadly diseases promulgated by means of morally criminal sewering and publicly poisoned water sources? It does seem to appear much as though the Government and most voters concerned, were bent upon unanimously confirming by heedless silence the horrible idea uttered in that noted sentence, said to have been born somewhere in this metropolis, namely, "the people be damned!"

All over Christendom, and especially in our young republic, great amounts of time, talent and treasure are spent in the name of sciences and arts, whose utmost results of research cannot equal a feather's weight as compared with the lives, health and happiness of the people now imperiled by the abuse and abuse of water and water sources. There has been set at the Golden Gate, at enormous expense, an observatory, whose records will yet make the name of Lick eclipse the fame stars of the most brilliant warriors of all time. Chicago, by the munificent help of an unassuming, kindly, far-seeing and loyal American now dwelling in this great and mighty center of wealth, is laying the foundation of a structure whose influence on human kind, if properly directed, is bound to far outrange even that of Rome. Other broad homes, broad leading thickly dot this shore of the republic, as gigantic light-houses; while in land, from the lakes to the gulf, and way to the Pacific, on every available hill, thicker than the sentry-boxes of martial Europe, stand the winsome fortresses of freedom—the public schools. Then, at many a point on our billions of acres of rich soil, rock and forest, both West and South, are growing scores upon scores of workshops of learning, whose skill will yet chip, grind and polish gems, whose luster will not be least in the crown of *our* queen.

Then again, it has been found out, and accepted as fact in social structure, as well as in hydraulics, that no stream can rise higher than its source; and that, if it clarifies by aeration and sedimentation, it gradually clogs its channel to a comparatively mere thread of clear water. In other words, it has been found and accepted that woman has brain and five senses and reason, and that, consequently, she can and should and must educate as freely and fully as man. Therein is the most potent promise of progress. Hitherto we have bred horses with ordinary common sense, and have trained the mothers to their utmost possibility. If possible speed was neglected or undeveloped, it was in the sires. And magnifi-

cent were the results. But we soon applied more common sense, and brought out and carefully recorded all possible speed of sires as well as dams. What is the result? The greatest speed ever known, and more promised. And Maud S., Sunol, Allerton, Axtell, Palo Alto, and many others are each worth a large fortune of 20 to 15 years ago. Woman, the mother, the wife, the sister, the sweet-heart—has begun educating toward the utmost; and in five to ten generations she, as the guardian angel of the home—the cultured and, therefore, twice mighty custodian of the lives, limbs and intellects dearer to her soul than her own existence—will be able to afford needed guards against this destruction of the best blood, bone and brain of her country's tender youth and childhood. But, pending this promised advance of woman to her natural and proper sphere, of what import is polished learning in men as compared with health and life and comparative freedom from death's sorrows among 65,000,000 of people?

Despite the most favored opportunity ever enjoyed in nation building, which way are we tending, if we allow annually 500,000 untutored foreigners, people not to our manners born, but diametrically the reverse, many of them confirmed criminals—to come and mingle their votes and ideas and blood and habits with ours whilst, at the same time, we allow one-fifth as many of our purest and best born young people and children to die from the effects of disease and death-seeding water? Then, think of the horrible results of checked typhoid, checked dyptheria and their weakening effect upon mind as well as body. Is it not plain that such neglect on our part is rapidly converting our magnificent national heritage into a mere moral, mental, social and political international sewer pitching toward the hell-pit of degradation, anarchy and ruin? Can we, as loyal citizens, and as members of an association so intimately concerned with this most important matter, longer carry the responsibility of not urgently asking the earnest, prompt and active attention of the Government to the dire waste, which is now filling grave-yards instead of public schools and places of profit? Can we longer afford to participate by silence, in so patent an act of moral treason?

I would not shut the doors against eager and honest seekers of bread, light and liberty; for such mean more wealth, power, progress and glory. But I *would* light the lamps. Four-fifths of all our criminals are uneducated. Yet it costs but $29.40 per year to educate a child in this city, while it costs $110.00 per annum to maintain a criminal in the penitentiary.

The gravity of our attitude seems only to be equalled by the clearness of the facts which prove it.

Preceding statements may show conclusively enough for us that immediate relief is imperatively needed. Indeed, for the most of us it is useless to rehearse them at all, for they are only too painfully familiar. But the people should be reached with these discussions of interests so vital to their welfare. So should those entrusted with the public power to right public wrongs. Hence, it seems to become a duty here to introduce more testimony of eminent scientists and recognized experts in all parts of this country and the distant sources of a large share of our population. Therefore, permit me to submit the plain, unbiased convictions and terrialy significant statements—officially made—of a score or

more of competent witnesses selected from among about three hundred able, honest, just, honorable men whose lives are being devoted to the progress of science and the welfare of humanity, and not one of whom, I am very confident, but would be heartily rejoiced and doubly grateful to see the water supplies and the sewerage of the entire country under the general watch-care of the Federal Government and the closer guardianship of the States.

As to the unfitness of water supplies from the ground, unless purified and filtered:

Prof. Pettenkofer, during 1860, clearly established as fact, by mathematical probability equal to 36,000 to one unit, that there actually was a causual relation between the lowering of the ground water under Munich, Bavaria, and the increase of typhoid fever in that city. In proportion as water rose in the ground, typhoid decreased, and as the water lowered, typhoid increased. [A most valuable and beneficent discovery this, and one for which humanity owes a debt of gratitude surpassed by none in all the great brood brought forth by this most inventive of all centuries.]

No one, who has carefully observed the ups and downs of epidemics of typhoid and of diphtheria, since the positive location and isolation of the germs of those diseases in water supplies, can have failed to notice that Pettenkofer's conclusion is most terribly accurate. Having tested it personally at Kansas City, Mo., and Middletown, Dayton and Hamilton, Ohio, I can vouch for its great effectiveness as a means of warning against danger.

W. F. Milroy, M. D., Prof. of histology, pathology and hygiene in Omaha's Medical College, has done substantially the same thing in his city. (See the Omaha Clinic for April, 1889.) In short, after more or less closely observing not less than 50 towns and cities whilst victims of typhoid in its various degrees and stages, and after testing a large number of water supplies in most parts of this country and Canada, I have not the least hesitancy in coinciding to the fullest extent with Prof. Pettenkofer, and in acknowledging that his theory is as naturally and inevitably correct as it is mathematically conclusive.

Dr. Baker, Secretary of the Michigan State Board of Health, in his paper on "Typhoid and Low Water in Wells," read before the St. Louis meeting of the American Public Health Association, clearly demonstrates for the State of Michigan what Pettenkofer did for the city of Munich: and, as both argue, it is clear that the lower the well, the greater and more inevitable becomes the drain of sewage into it.

As plainly illustrated at Hamilton, O., Memphis, Tenn., and along the coast of New Jersey and Long Island, pure ground water may be pumped from below a bed or beds of sewage contaminated water at the surface, though said surface water may rise and fall as a result of such pumping. But most wells draw down water in the shape of a funnel, and hence, the deeper they are pumped, the greater the tendency of sewage to them. For the same reasons, low streams are but little, if any, safer than low wells. The same laws of gravity govern both about alike; and whilst aeration, attrition and sedimentation help to purify the *core* of streams, the extra warmth of their water largely increases the breeding of disease and other germs unfavorable to the procurement of wholesome, palatable water.

Of course, in water supplies from wells and from streams, much depends upon the nature of soils and other alluvial formations. Whilst in some, such as the immediate valley of the Ohio, sewage percolates with difficulty, though freely diluted; in others, such as along the Rio Grande, soil and clay, when saturated, are almost like sponge. The Platte and its many contributaries are much the same; whilst the almost infinitely useful Merrimac, utilized from source to sea as a means of motive power, a fish pond, irrigating ditch, bath-tub, water supply, sewer, and "placid wattery mirror" into which the sweet Evangelines and song-ful Sapphoes of a hundred towns, dip their dainty fingers as they languidly dishevel under the melting glances of great New England's hopeful sons—is conditioned much like the Ohio. So is the St. Lawrence. The Missouri valley, on the contrary, is quite porous, and accordingly dangerous to wells, cisterns and streams from the mountains to the sea. (I say sea, because that part of the Missouri which is called Mississippi is a geological misnomer.) Yet Prof. Vaughan, Director of the Michigan State Laboratory of Hygiene, says that the soil of a single privy, built upon nearly level ground, can be detected fifty feet from the vault, plainly. And the Illinois State Board of Health, in its "Preventable Disease Circular No. 4" says: "The contaminating distance varies according to the nature of the soil and depth of the well; in a loose, porous soil, a well 30 to 40 feet deep will be dangerous if within 100 feet of typhoid premises." But you, doubtless, are aware that all household commodities of over one-half of the American homes are contained within a square of 50 feet. Prof. Chandler of this State, goes further, and with ample reason, says, curtly and forcibly: "You may take it as a rule that unless your cess-pool is as tight as a bottle, the sewage will find its way to your own or to your neighbor's well."

Prof. Shepard, Chemist of the Dakota Agricultural College and Experiment Station, once said: "I venture to say not one person in fifty knows at what distance he lowers the level of the ground water, when he lowers the water in his well by excessive pumping. It has been demonstrated that in soils somewhat similar to ours the level of the ground water is lowered for a distance of 200 feet in all directions from the well, while under the most favorable conditions the circle of influence may have an influence of over 2,000 feet. Now, for the sake of illustration, let any owner of a well in this town take a line 200 feet long, and with his own well as a centre, let him strike a circle, then let him count the privy vaults, old and new, cess-pools, old and new, and all other sources of pollution within the circle; then he may know, approximately, upon how many reservoirs of death he is drawing when he works the handle of his pump."

According to all this and further testimony, paradoxial as it may appear, you may notice that to "clean a well," as it is usually termed, by clearing it of water entirely and "scraping the bottom," is simply to draw in more sewage, and, consequently, to make that well more positively dangerous.

Taking one more step onward in this broadening path of chilling facts, listen to Prof. C. F. Chandler, of Columbia College, who thus sets forth the conclusions of extensive and highly instructive practical study (see p. 78 of "Women, Plumbers and Doctor"): "As a rule, there is but little faith to be placed on analyses of well water if there be reason to suspect that the water is contaminated. I myself never feel like assuring

a man that, because I find his water in a fair condition, he is safe from typhoid; it may be that at the time his water may be good, but the next week it may be bad. So much depends upon the state of the soil, the level of the cess-pool, the season of the year, and so forth, that it is always rather against my conscience when I tell a man that his well is safe."

Dr. Smart, Major and Surgeon, United States Army, makes the following statement in "Annals of Hygiene, March, 1887": "Usually in such wells (those contaminated by typhoid excreta) the sewage inflow is so great that the chemical results show an undesirable contamination; but in many instances the inflow is so small, or the purifying influence of the percolation through the soil is so great, that the infected water may give a fairly good showing on its analytical record. In other words, the quantity of infected sewage necessary to the spread of typhoid by a well water is so small as to evade detection by chemical methods; or the influence of a filtration, which effects the destruction of ordinary organic matter, leaves the specfic poision unaffected and in full potency. So well are these facts recognized and acknowledged, that the health officers of many cities, having a trustworthy general supply, have not hesitated to close up the wells within their jurisdiction."

It appears safe to say that there no longer exists intelligent reason to doubt that it would be an act of great mercy and public benefit to fill up all wells at least in cities, as Detroit has dared to do, and to allow no more to be dug, driven, jetted or steamed out, within corporate limits.

The farm-house and country home need other, but equally radical treatment for the public good.

The American Public Health Association's Committee on the pollution of water supplies, in its report read at the annual meeting of that association at Milwaukee, in November, 1888, deserves the most careful consideration of towns and villages, where it is still supposed that chemical analysis is sufficient. It says: "We acknowledge that typhoid fever is propagated by an infectected sewage in a well water when all organic trace of the sewage has disappeared through the agencies referred to." (Chemical and biological changes.) It further states:

"There are two kinds of organic matter in the dangerous sewage—matter which, by the absence of life, is given up to decomposition and reduction to harmless inorganic forms; and matter which, by its vitality, is preserved from these influences; and we acknowledge that in the well water the former may be reduced, while the latter retains the full measure of its virulence."

Elsewhere, referring to its annual report, it goes on to say: "Chemical analysis was shown to be, in most instances, inadequate to the detection of sewage, unless the sewage is present in unusual quantity, or the water unusually free from other organic matters; and the conclusion was reached that the inability of the chemical methods is of no practical importance, as the presence of sewage in the water supply can be determined by the sanitary inspector; and, further, that for protective purposes the knowledge that sewage enters the water is all that seems to be required, *because where there is sewage there is danger of typhoid infection*. Your committee desires to give special emphasis to last stated clause, because it believes that the endemicity of typhoid fever in our cities is in great part due to the sewage in water supply."

In Pepper's System of Medicine, Vol. 1, p. 320, is found, in an exhaustive article by Dr. J. H. Hutchinson, of Philadelphia, this statement: "The rich are not only as liable to contract typhoid fever as the poor, but the disease is also quite as fatal among them. Murchison found from the statistics of the London Fever Hospital that the mortality is not greater among the destitute than among the better class of patients, and expresses the opinion that in private practice enteric (typhoid) fever is probably more fatal among the upper classes than among the very poor. Chomel and Gorget seem to have reached a similar conclusion."

Dr. George Wilson, Fellow of the Sanitary Institute of Great Britain, etc., speaking of typhoid fever (see Hand book of Hygiene, 5th edition, p. 208,) proves not only that "the poision of the fever may be conveyed through the agency of water from the sick to the healthy, but that this is the most common mode of propagation." Sir W. Jenner, than whom no higher authority could well be quoted in commenting upon this point, also said: "The spread of typhoid fever is if possible less disputable than the spread of cholera by the same means. The bowel excreta of typhoid fever, with the water supplied for drinking purposes, is the most efficient cause of the spread of the disease, and the diffusion of the disease in any given locality, is limited or otherwise, and just in proportion as the dwellers of that locality derive their supply of drinking water from polluted sources."

Massachusett's State Board of Health enjoys the high distinction of a bold pioneer in setting forth this truth in a way to be understood by the people. In its Annual Report of 1879 is found this unmistakable declaration: "So far as Massachusetts is concerned impure water is one of the most common sources of infection from typhoid fever."

The Michigan State Board of Health, (see its "Prevention of Typhoid Fever,") and the State Board of Health of Illinois (see its "Circular No. 4 on Preventable Diseases,") and many others, have since announced like conclusions regarding their own States.

Dr. Frank P. Foster, editor of the New York *Medical Journal*, remarks: "The water used for drinking is so commonly recognized as the chief vehicle of the germ of typhoid fever that even isolated instances in which it is evidently not at fault are of interest." (See No. of Oct. 22nd, 1887.

An eminent Western Sanitarian, James C. Bayliss, of Nebraska, in "House Drainage and Water Service," says: "In country districts the germs of typhoid fever are most frequently communicated to the human system through drinking water from wells and springs contaminated with impurities. This also occurs to a great extent in cities and small towns not provided with water works, and in which the inhabitants are dependent on wells necessarily sunk in close proximity to privy vaults, and cess pools for the reception of house drainage."

In Sajous "Annual of the Universal Medical Sciences," 1888, Vol. V., p. 252, appears this statement, which, under the present circumstances, affords the united opinion and conclusion of the leading experts of France, Switzerland and many other European States. Alluding to the Congress of Hygiene of September, 1887, at which M. Brouardel opened the discussion of the mode of propogating typhoid, it says: "Brouardel was sustained in his opinion that the vehicles for the transmission of typhoid fever germs were water, air, and clothing in contact with the sick; that

the great source of the transmission of the disease was the pollution of drinking water."

Here is another witness of no ordinary ability, who makes a suggestion—or rather drops an incidental warning—of great weight for city and town people, who are compelled to depend upon men who, in some way beyond the comprehension of even a philosopher of the acumen of Bill Nye, *will* mistake the dairy's pump for the dairy's cow. I allude to Dr. Edwin R. Maxson, LLD., of Syracuse, this State, who says: "The most common vehicle of the poison appears to be drinking water contaminated through sewage, either when drank alone or with milk, with which it has been mixed."

In Corfield's "Treatment and Utilization of Sewage," p. 296, you will find this statement copied from The English Rivers Pollution Commissioners in their sixth annual report: "The investigation of the epidemic of typhoid fever at Lauzen proves that very efficient filtration does not prevent the progagation of typhoid fever by water.

Nothing short of abandonment of the inexpressibly nasty habit of mixing human excrement with our drinking water can confer upon us immunity from the propagation of epidemics through the medium of potable water."

I have alluded to the apparent impracticableness of purifying water of disease germs by means of filters alone, and held that it must first be purified, and then filtered in order to be safe for drinking purposes. The following is the highest corroborative evidence of the justness of the position so taken: "From these results," says the U. S. National Board of Health (see Annual Report of 1882, p. 582,) "It appears very clearly that sand interposes absolutely no barrier between wells and the bacterial infection from cess-pools, cemeteries, etc., lying even at great distances in the lower wet stratum. At this point in our work it seems as though the filtering capacity were wholly dependent on the size and intricacy of the interstitial cavities; and that in the dry-air filters there is a critical limiting point, beyond which there is no filtering. And the same remarks seem to be true in different degrees with regard to the filtration of liquids. Here far greater fineness and compactness of grain and intricacy of passage are needed than are requisite for air filtration. While sand of 20 ° is an excellent air-filter, sand of 100 ° in long columns is worthless for water, and the critical limiting point below which soils begin to exercise any filtering action probably verges on the size of grain of an impalpable powder."

Further on this report says: "It would appear that the first inference from these experiments is that no substance sufficiently porous to allow of the passage of water can eliminate spores or bacteria from that water, even when moving upward by capillary attraction. There is no current so gentle that it cannot buoy these infinitesimal bodies."

On this same subject, in its report of 1888, the Am. Public Health Association's Committee on Pollution of Water Supplies, closes a most convincing argument and statement of demonstrated facts in these words: "*Since natural filtration is powerless against the infection of typhoid, it is evident that artificial methods can give no guarantee of protection.*"

Now, Mr. President and Gentlemen, it is sincerely hoped that such a multitude of facts and conclusions, arrived at and established by so many eminent authorities, and repeatedly tested for from two to twenty

years by over 300 careful, conscientious, systematically trained scientists from the best schools of both continents, with uniformly corroborative results—may be deemed worthy of your favorable consideration, and may lead you to a hearty support of measures necessary to direct the earnest attention of the proper authorities to these destructive evils, and the public mind to a prompt and intelligent reception and application of such constitutional provisions and protection as may result.

In the hope of making the foregoing facts and suggestions of practical service, they have been embodied in the following shorter and simpler suggestions or rules, namely:

I. First purify and then filter all drinking water for human beings, milch cows and house animals.

II. Avoid sprinkling in and near the house with water polluted with disease germs.

III. Drink no unpurified water from any well that is less than 500 feet from any privy, old or new, any cess-pool, old or new, if the water in such well is below ten feet from the surface of the ground, unless such well is sunk through a thick bed of clay to water in sand and gravel unreached by surface drainage in the neighborhood.

IV. Drink no unpurified water from any kind of well reaching an underground flow of water coursing toward you and receiving any of the sewage of dwellings, graves, &c., within a distance of not more than five miles.

V. Drink no unpurified water from any immediate proximity to dwelling, burial place, slaughter house, or any kind of sewer except the head of that well's supply is so strong as to force its water steadily to the highest sewage level of a radius of five miles, and the source of supply is not less than ten miles distant. (The water supplies of Memphis, Tenn., Hamilton, O., afford safe, practical illustrations of the important principles upon which this suggestion or rule is founded. Per contra, in this island is a well, drilled in granite for hundreds of feet, which revealed the presence of dangerous sewage pollution at several points to its deepest depth whilst being drilled.)

VI. Proper water-works and proper sewage are prime requisites in a civilized community deserving permanent progress.

VII. No hamlet, village, town or city of 200 souls and upwards should be without sufficient and proper water-works and sewerage.

VIII. No water supply is sufficient and proper which is not free from disease germs and matters which effect disorder in consumers.

IX. No sewerage system is complete and proper which does not extract and consume, or safely utilize the solids, and sterilizes and filters the liquids before liberating them.

X. No water-works should be without a good, accurate metre for every family or household. The metre is the best existing check on the waste of water, which is even more dangerous than costly.

XI. Never "shut off" water for non-payment of dues. It is too dangerous for immediate consumers and it exposes innocent neighbors to too many grave dangers.

XII. Trust not to chemical analysis alone.

XIII. Rely on nothing less than the closest bacterial analysis. The two are none too safe.

XIV. Cultivate the closest intimacy with your water-shed, water sources, and immediate supplies.

To one of our distinguished members, an analyst of rapidly extending influence and usefulness, I am indebted for suggestions resulting in prolonged efforts which, I hoped, would accomplish the thorough purification and filtration of water by one single treatment. I allude to Prof. Leeds' ingenious idea of purifying water by making the different kinds of dangerous germs prey upon, and thus destroy, one another whilest leaving the water to filter through the warring mass clear and pure. But the most complete coating of vegetable wool and fine sand (which appear to be the materials best adapted to the purpose) and even a baked clay tube, a half inch thick, thoroughly and thickly coated with the semiglutinous mass that such germs form, allowed so many germs to pass unharmed that the experiment was abandoned as hopeless of satisfactory results.

To Professors Leeds of New Jersey; Snow of the Kansas State University; Langenbeck, City Analyst of Cincinnati; MacFarlans, Chief Analyst of Canada; Dr. A. W. Riley, Practitioner of Omaha; Monsieur Pasteur, of France; my worthy Professor and friend, Kohler, of the University of Berlin, Prussia; Mr. J. A. Bavermport, Engineer and Inspector of the Nantwich Rural Sanitary Authority, Great Britain; Mr. Rudolph Hering, C. E., of this city, and Prof Salmon, usually of Washington, D. C., I am under lasting obligations for many of the facts and experiments and observations resulting in the above suggestions.

The question of sewage in towns or in country, with or without water works, is getting to be a most serious one, and no change, except for the worse, can be looked for from delay in discussing it. It seems to me that the dangers to health, lives and happiness of our people, and, consequently, to the genuine thrift and prosperity of this nation, are far more imperiled by our reckless, unscientific, wasteful and morally criminal methods of sewering, than by all the wars possible from without, and all the strifes which discordant elements can foment within. It appears to be high time for the attention of our statesmen to be called to the abuse of our water supply sources, and the devising of remedies against the ruin which must result to the comfort, health and lives of the people unless present abuses are estopped.

We *may* need "free wool." But we *should* have pure water. The national "pure food bill" is a long, stout, steel spike driven home through the broad, sound, solid and seasoned plank that shuts a large hole in every party platform. It is the promise of a long stride in advance. But is it wisdom? Is it scientific? Is it ordinary common sense to purify the food and continue to poison the water more and more? Pure water is the prime essential of life and health, not so much pure food.

Congress has devoted considerable attention to the excluding of the greedy, unassimulating Chinese from this country. They are a mere moral and dollar malady. Why should not Congress spend as much time and attention in trying to keep out of the grave annually not less than 100,000 young men and women who now perish from preventable diseases? 100,000 every year! 1,000,000 every ten years! 2,000,000 in twenty years! Think of it. Twice the number of the frightful, the gigantic, the horrible sacrifice of precious lives which we so lately paid

at the altars of right and justice in order to save our common home from ruin!

Can it be that as a people, we have again become so engrossed with the pursuit of wealth and glory as to forget, or neglect to protect, the flesh of our flesh and the bone of our bone? Can it be that we have again become so engrossed with our love of luxury and worship of the wing-footed god as to protect Europe from poisonous meats, because she pays in gold, whilst we neglect to save our offspring from preventable death because they pay only in love to us and service to their country? Can it be that we have again become so engrossed with the love of the power of wealth, or of the spoils of partisanship as to forget that every harvest inevitably must be of a kind with the seed sown? The dragon teeth of solemn duty neglected are not the seeds that push forth rose buds, nor the pure, white lilies of peace for God's sun to kiss and freight with fragrance and delight. How long may it be before we again need 500,000 strong young men, or a million, or, may hap, 2,000,000 to breast against monarchs envious of our resources and freedom? Or to face foes now entrenching on our own soil? As we build steel ships, why not save our sons to man them, and our daughters as mothers for more men to build up bulwarks of homes consecrated to the perpetuation of the republic and the glory of its God? Cannot the country waive discussion of the free coining of silver until this free cutting down of the flower of our youth is stopped?

If, perchance, some morning, the roaming, idle red man on his reservation—a useless leech on the National treasury—happenes not to get better beef and bacon than does the Czar of all the Russias, or the stirring young heir to the crown of Charlemange, or the President of wealthy France, or the most gracious Queen of mighty Britain, keen-nostrilled committees of Congress (or the equivalent) are forthwith appointed, and trained army officers are detailed and furnished at great expense, to go and inspect that beef and bacon and solemnly and carefully report to the end that this leech in human form may be at least as wholesomely fed as the monarchs of the Old World. And Why? Simply because the keen sense of justice and equity in our people has been misdirected by well-meaning but impractical missionaries of religion. The Indian, as a consequence, is robbed of the liberty and ennobling necessity of earning his own living, and is kept, as a rule, a poor, dependent, surly, useless wretch and ready cut-throat—and all, forsooth, in the name of justice as interpreted by deluded religious sense. But Congress, ever keenly perceptive of public sentiment, promptly votes all necessary appropriations.

Do you imagine that it would not promptly listen to a proper and just petition from us? Or that it could not quickly devise some means by which to protect the sons and daughters of industrious, self-supporting, peaceful, tax-paying citizens from the steadily increasing dangers of preventable disease and death?

The protection needed cannot be effected by stopping immigration, as has been supposed. Besides, stopping immigration would not be practical. Poor, hungry, oppressed and weary of war and military service, as are most of the world's millions to-day, no power on earth can close upon them these fertile plains and rich mineral mountains of ours, which offer resources to all industries and refuge from all want. Again, history does not indicate that such an act would prove wise even if practicable.

Some equitable, just and popular way should and must be devised and applied. This task we may safely trust to the genius of our statesmen in both departments of the Government, I believe. In my humble opinion, however, a water supply and sewerage commissioner or commission, with sufficient power and means at disposal, and, if possible, as separate from political parties and party influence as is the Supreme Court, could be constitutionally established, and would afford the relief so urgently needed.

Our people reason. All they need is proper instruction. They enjoy and are benefited, persuaded and enthused by a good face to face talk. What should be started and maintained for a considerable time, from ocean to ocean, is a water supply and sewerage campaign that should eclipse the Cleveland-Harrison cyclone whose thunderings and darting bolts are already heard and seen rising zenith-ward from every State and Territory. Its crash and sweep in the end must be terrific. For aught we know, the moon may yet turn red and the evening star blue, and the sun's great spots be fused in white heat. But the sky will clear brighter than ever after the final shock of mind with mind on the stump, and party with party at the ballot-box, and the average voter will be better informed, more strongly entrenched in his party principles, in his loyalty to the Republic, and he will become a keener lover of light and liberty than ever for this quadrenial conflict of honest opinion.

Could we look for dissimilar results from an intelligently conducted, stirring, ocean to ocean campaign against the general and systematic practice of spreading disease and death by reckless sewering into the available water supplies? And do not facts call most urgently for such a campaign?

It is perfectly safe to say that our annual waste of human life or energy by preventable diseases and death, valued at the lowest price put upon such life by the most grinding of corporations, now amounts to not less than $500,000,000 each year; $1,000,000,000 every two years, and $5,000,000,000 every ten years—a sum four times greater than our National debt. In other words, this great, intelligent and most religious people of the globe, whilst spending not less than five million in treasure and cultured life annually to enlighten and comfort "benighted nations of the earth," is heedlessly allowing, every year, at least 100,000 souls of the younger and more energetic element of this nation to sicken, languish and die with disease which, it is well known to science and practice, are positively preventable not only, but are a shame and a disgrace to such as fail to prevent them. And thus, irrespective of the wide-spread sorrow, suffering, anguish and oppressive expenses which such neglect entails upon the people, the annual loss, in dollars and cents brought about by this waste, if interest be included, foots up in only twenty years, a sum greater than the total expenditures of the United States Government for its 103 years of existence. And, mark well, instead of abating, this waste is steadily and rapidly increasing, and must inevitably continue to increase until radical corrective remedies are applied.

I firmly believe it is with you to say whether this great social and morally criminal waste shall continue or not. I firmly believe that this association, intimately connected as it is with the supplying of water to a large majority of the people, has but to call the attention of the Government to the actual condition of things in order to have radical remedial means

quickly devised and applied. And I firmly believe it our solemn duty here and now to lay this matter clearly before the President and Congress, and let them bare the awful responsibility of longer inaction if they dare.

There can be no question as to the constitutional power of Congress to remedy such flagrant evils. Article First, Section VIII., of the Constitution of the United States plainly and clearly provides that: "Congress shall have power:—To lay and collect taxes, imposts and excises to pay the debts and provide for the common, * * and general welfare of the United States * * and to make all laws which shall be necessary and proper for the carrying into execution the foregoing powers, and all other powers vested by the Constitution in the Government of the United States, or in any department or officer thereof."

Nothing can be clearer than that this grant of power covers legislation necessary to protect water supplies, and thereby the lives and health of citizens. Under this same power immigration is controlled. If immigration can be encouraged or discouraged under it, and controlled as it is, inclusive of moral, physical and financial qualifications of immigrants, then emigrants can likewise be controlled, whether it be by way of graves or sea-ports.

But logic here is utterly useless. The case is self-evident. Accordingly, Congress has repeatedly legislated "for the common welfare of the United States" in matters of health and life not only, but of interests far less important. It is now under consideration, besides Senator Paddock's "pure food bill," Senator Gallinger's bill for the construction of a national hospital for victims of pulmonary consumption, a disease which may soon be generally recognized as preventable.

May I not here then, in view of the foregoing facts—the graves of millions of strong young people who might now enjoy life and bless their homes and country; the sorrow and desolation that succeed to their untimely demise; the thousands who are now languishing unto death; the 240 graves that close every day over more victims amid the sobs and agonizing groans of loving ones bereft—in view of such utterable waste and desolation that are positively and readily preventable—may I not, I ask, submit these few words as the sense and request of this association to the proper authorities? They read thus:

To the President and the Congress of the United States:

WHEREAS, it appears that the people are submitted to much discomfort, great suffering, the sorrows of death, and the nation to an annual loss of not less than one hundred thousand souls from among the younger and more energetic citizens by the spread of preventable diseases arising from the use of water poisoned by means of sewering into the ground and the surface sources of water supply; and

WHEREAS, no betterment of existing conditions can reasonably be looked for except from the Federal Government assisted by the States, and this great wrong and waste must not only continue, but rapidly increase, unless corrective measures be forthwith enacted and applied:

Therefore, we most respectfully and urgently pray that you may be pleased to grant this weighty matter the prompt and careful attention it deserves.

Now, Mr. President and gentlemen, it seems to me that all these

simple suggestions are so plain, the accompanying facts so clear, and your loyalty to home and country and kind so firm that there is no need of argument or effort of rhetoric to move you to prompt and vigorous support of an act so evidently urgently needed, and a petition whose influence, if productive of intended results, can but evoke grateful thanks not from this republic alone, but all the republics of this vast continent, and from all quarters of the globe where humans congregate and homes are built, and heart tendrils twine themselves about those lives and forms which God entrusts to parental arms at the altars of love.

Surely, when our mothers, wives and daughters bow down to the black edge of the grave to bring forth life, and spend their youthful charms, strength and best years a constant sacrifice in order to rear sons and daughters toward the highest possible manhood and womanhood, which is their natural and only way of expressing loyalty to home, husband, country and God, you will agree that we, as sons, husbands, and fathers, who alone cast the vote and draw the sword, are, in the very nature of things, bound by every faith and power in us to protect to the home and the republic the sacred fruits of such peril, effort and sacrifice.

We are no longer boys, playing "house-keep" with the next neighbor's rosy innocence, when mother's call to meet honorably and for ever ends all responsibility of some tremendous business enterprise, some daring sea adventure, the bombardment of the Moscovite's capital with the "Little Corporal," or, with the regal scepter of towering intellect, the swaying of the proudest Senate of this enormous globe. Oh! no. We are men now, in the full sway and sweep of the stress and struggle of life—chained to duty as Prometheus to his sea-circled rock. And we dwell in a land where light comes not from a throne, but from the people. Between duty and destruction lies our pathway onward and upward. Return is impossible. Responsibility is ever upon us, calling at every step: "Attention! Think! Ready! Speak! Do! Done!" and tosses the results to the blindfolded goddess to toss in turn into the balances and weigh for or against us, and show each wise or unwise; just or unjust; faithful or unfaithful; true or traitor to the awfully sublime trust of guard and protector of home, and brave and watchful servant of the common weal.

THE SECRETARY—I desire to say, at the request of Mr. Jones, that his complete paper on "The Kansas City Case" is here in bound form, and any person may have copies of the same by applying for them.

MR. ESPY—I have listened with a great deal of care and attention to the article just read. I think that the article was prepared either by a person who represents a filter, or it was prepared through some medical society. I am satisfied, as far as I have looked into that article, that it is one which the American Water Works Association should not under any circumstances adopt or receive. I want to be plain. My reasons for that, gentle-

men, are these: It is finding fault with, or condemning, rather, the water supply through our whole land; and, above all things, there is an admission in that article of the germ theory. You know, as well as I do, that the medical profession is divided upon that subject. In the city of Wilkesbarre, from which I come, we had an epidemic two or three years ago, and also in the borough of Plymouth, where they had that fearful epidemic of typhoid fever, and a suit was brought against the corporation to determine whether the epidemic was due to the water or some other cause; and it cost the corporation a large sum of money for litigation. The question whether the water was the cause, or whether it was the fault of the borough in not properly sewering, was not settled. You will find all the way running through this article that the germ theory is accepted as a settled fact; that there is bacteria in the water which causes the trouble. In the city of Wilkesbarre, where we had this typhoid fever, there were certain streets, in the heart of the city, in which there was not a particle of the typhoid; yet in the outlying districts there was. I think that the American Water Works Association ought not to discuss such a subject as that, or to receive such a paper as that, because if there should be an epidemic from typhoid in any place, the admission of this article on our list, and its publication in our reports, would be admitting the germ theory. I move that it be received, but not published.

Mr. Milne (as presiding officer)—Will the gentleman withdraw his motion for one moment. A gentleman well-known to you all, is very much limited in time, and he will make a few remarks by request of the convention before he leaves us; and then we will pass to the consideration of your motion, if it should be the pleasure of the convention. I have great pleasure in introducing to you Mr. Fteley, Chief Engineer of the Croton Aqueduct Commission.

Mr. Brush—Mr. Fteley is a man whose engagements are numerous, and it was at great inconvenience that he came here this morning. He came at the request of the President, in order to inform this Association as to the present status of, and give information in relation to, the water supply of this metropolis.

MEMORANDUM—"Mr. A. Fteley, Chief Engineer of the Aqueduct Commission, was introduced by the presiding officer and said that, at the invitation of the President of the Association, he was very glad to appear before the members and to offer some informal remarks as to the construction of the new Croton Aqueduct. He stated that the facts had been published before, but that it might be interesting to the members to hear a condensed statement of the principal features of this great wrok, which is intended to procure for New York a daily supply of at least 250,000,000 gallons a day."

MR. GARDNER—I move that the thanks of the Association be tendered to Mr. Fteley for his exceedingly interesting remarks on the Water Supply of New York.

MR. DIVEN—In supplementing that motion, I wish to say a word in addition to what Mr. Brush said. I labored long and hard with Mr. Fteley to induce him to make this address. I am glad now that I labored and prevailed with him. I second Mr. Gardner's motion.

The motion was put and carried.

THE CHAIRMAN—Mr. Espy now has the floor.

MR. ESPY—I made a motion that the paper just read by Mr. Monjeau be received and not published. My objection, as I have already stated, being, first, that we should not condemn all surface water supplies; and, second, the admission by this Association of the germ theory. I don't want this paper published, and spread broad cast, as part of the proceedings of this Association. If any of you, as officers of a water works company, have supplied a city with water when there was a fever epidemic, you will remember how delicate and unpleasant a position you were placed in. You did not dare to be on the aggressive, or defensive side, as to what was the cause of the epidemic, but simply keep cool and quiet and take all the abuse imaginable, and at the same time stand squarely on neutral ground. The paper states positively, again and again, that the germ theory is a settled fact. This, gentlemen, is not true, and not one of you here are willing to say so. In the suit I referred to heretofore against the Plymouth Water Company, there were physicians,

as expert witnesses from different cities, some of whom were ready to sustain this theory; but there were a great many ready to testify it was all nonsense. Gentlemen, surface water supplies are the safest and most healthful in the land to-day; and I object to its being condemned, and replaced by water obtained through the driven well system. I understand that the gentleman has devoted much time and labor in the preparation of this paper. But, all there is in it, that is valuable, could have been written on two pages. Then as a safety, in expense, and as a protection to the members of this Association, I hope the paper will not become a part of our printed proceedings.

Mr. Diven—I move an amendment that the paper be referred to the Executive Committee with power to act in the matter.

Mr. Wanner—Has the first motion been seconded?

Mr. Diven—I will ask the original mover if he will accept the amendment.

Mr. Diven's amendment was seconded, and accepted by Mr. Espy, the mover of the original motion.

Mr. Wanner—We ought to know if this motion, if carried, will stop discussion on the question.

The Presiding Officer—All those in favor of the adoption of the motion will say ——

Mr. Linneen—I differ with the ruling of the Chair on this question. It is not fair; you cannot peremptorily dispose of a question of this sort and take it away from this meeting. Before this question is put to the house we have a right to discuss it, and see whether we will vote for it or not. If you put the question without allowing an opportunity for discussion, it will not be proper.

The Presiding Officer—The question is, shall the matter he referred to the Executive Committee.

Mr. Linneen—I have listened with considerable interest to this paper by Mr. Monjeau, and I am free to say that he deserves considerable commendation from the

members of the Society for the pains he has taken in the preparation of this paper. I am informed that the paper was prepared without access to his library, with one arm in a sling, and the right one at that. I think he started at Genesis and finished at Revelation. If he had had the use of his library in front of him it probably would have included the History of the Reformation.

Now, I am opposed to side-tracking this paper, or giving it to the Executive Committee to dispose of. There is intelligence enough on this floor to dispose of that paper. I do not believe in relegating questions that come before this body to select committees, to be disposed of as they see fit. What is the matter with our disposing of it?

Mr. Wanner—The gentleman who has just occupied the floor, has given my ideas on the subject probably better than I could. The chief objection to the paper has been its great length. But the subject, apparently, is so large to the mind of the gentleman, so fertile, so eloquent, that he could not stop this side of the point he did. I think it would have been better for the gentleman—and he no doubt would have received more attention—if the paper had been shorter; but that should not detract from the worth of what he did say on this important subject. There is no question in my mind but what it is a step in the right direction. We have got to meet truths, and they are being forced upon us right along, and very rapidly. See how water works have been multiplied during the last ten years; and it is these important questions in connection with them that are forcing themselves upon us. What he says is brought about by necessity, by the spirit of the times; and he may be simply in advance of some of us. That is no reason why the paper should be relegated to the Executive Committee, or why it should be sidetracked. I was very much pleased with his production, and believe that the great majority of the gentlemen are in sympathy with him, and I rather regret that this motion should have been offered at all. The paper should have taken the usual course. Now, gentlemen, it is well known that we are moving in the direction indicated by the gentleman, and this is simply a step in the way of bringing about purity,

by filtration or otherwise, of the water with which we supply the people. Now here is a water works constructed at a new place. The wells have been supplying these people for years, and the water in them is becoming impure. The less the water is used out of the wells the more impure it becomes. Is it not proper that the town authorities or the city authorities should take the matter in hand and prevent the use of water from these wells? Some one would say that is in the interest of the water companies. It may be so, to some extent, but it may be more clearly in the interest of the health and life and well-being of the community. I know of two cases of the kind where water was introduced within the last few years, and where at both points the people were afflicted with typhoid fever, and only in those cases where the water from the wells was used. However, there may be such a thing as being over-critical. Still, we ought to meet facts, and this must be met by our town, county and state authorities. It has already been taken hold of in a great many states throughout the Union, and they appointed State Sanitary Committees to take up the consideration of the pollution of waters, whether surface or underground. But state laws are not enough. We have a strong committee in Pennsylvania on that subject, and they are doing good and effective service; but what good can we do so far as the pollution of streams in the state of New York, which run into Pennsylvania, is concerned. Therefore, Mr. Monjeau is right, and his paper is only a step in the right direction. There should be national laws in these cases; laws ought to be passed at Washington to relate to the whole country. Am I not right in this, and is he not? Congress out to pass laws for the whole country, and the State Legislatures enact laws in harmony with them.

As to this germ theory, it is really a serious matter. Here the lives of dear ones are involved, and in its consideration we must lay aside all thought of monetary or other selfish ends. I have in mind a large Normal school established years ago. Not long since, several of its members were taken sick; then in a few days more, and after a while nearly the whole school became afflicted – from five to six hundred. One of them died before leaving the school, five or six more of those who went

away complaining, and everybody wanted to know what was the matter; what had afflicted these people. Such occurrences are frequent throughout the country. I could refer to a number of them. In the case of the school, they examined the well, and found there two or three dead rats, a few toads and snakes, and altogether enough animal poison to have killed everybody in the school. Is not this a subject of importance? I submit that the paper is of great importance, and ought to be received by the Association for serious consideration.

Mr. Denman—If I understand the Constitution of this Association, it is within the scope of the authority of the Executive Committee to examine papers and reject them, or accept them, as they determine. Am I not right? Now it seems to me it is the proper thing to do. A gentleman has arisen and objected to the spreading of this paper upon the minutes of the Association. It has been moved to refer the matter to the Executive Committee, to which there seems to be objection. Now, as a matter of opinion, I doubt if there is a quorum here hardly who have heard that paper read from beginning to end. Then how are we competent to vote on the question of its reception and publication. Would it not be better to refer it at once to the Executive Committee with power to reject it entirely, or accept such items as may not be found to contravene the rules and customs of the Association. I should be very decidedly in favor of referring the matter to the Committee. There is another reason beyond this; we will never get through with the business on our programme, if we give much more time to this matter. At every session of this Association, but two of them, we have never yet finished a programme. You invite gentlemen to prepare papers, and then you shut them out. I have been a victim myself, and it is not just the correct thing. I think, gentlemen, speaking in behalf of the gentlemen who yet have papers to present, that we ought to refer this matter to the Executive Committee, and not spend our time in discussing it.

The Secretary—I desire to say a word to correct Mr. Denman. The Constitution gives the Executive Committee the power to examine papers and reject them

before they are read at the meeting; but I take the ground that after a paper has been read before the Association, it is then the property of the Association and is not at all within the province of the Executive Committee to receive or reject. Further—as a member of that Executive Committee, which is composed of but very few, I do not wish to have the responsibility saddled upon me of speaking the minds of this Association, and I shall vote against it, and hope that every gentleman will vote down the motion in its present form.

Mr. Gardner—I want to make a side remark. I beg to call the attention of the members of this Association to the fact that no paper read upon this floor, and no individual opinion expressed upon this floor, binds this Association in any way whatever. We had an able paper yesterday from Major Jones, of Kansas City, giving the history of the "Kansas City Case." That does not bind this Association in any manner, shape or form. Mr. Monjeau's paper does not bind this Association; it does not include us in any way, shape or form; it is simply the expression of his individual views.

Mr. Espy—Of course, two pages would have contained about all there is in that article pertinent to this Association. The rest of it, I think, ought to be entirely left out. In order that there may be no more discussion, and that we may proceed with our important business, I, the orignal mover of the motion, now call for the previous question

The Presiding Officer—Shall the main question be now put?

This was carried unanimously.

The Presiding Officer—The question now recurs to the original resolution, in its amended form, that this article be referred to the Executive Committee, with power to act, as to whether it should be put in the proceedings or not.

A rising vote was taken; and the motion was declared to be lost.

Mr. Linneen—Mr. Chairman, I want to say this, that at the Chicago meeting, two years ago, there was a

resolution passed by this body, unanimously, that all papers that may be prepared for reading before this Association be examined by this Committee, before being presented to this body, and the expunging, if any, shall be done at that time. Now you ask gentlemen to prapare papers to read at your meetings. It is no easy task for members to do this; and simply because they do not strike the fancy of some individual on this floor, because they contain some statements that may crowd his corns a little bit, they are to be relegated to obscurity, wiped out, and no credit given to the man that spends his time and money to come here and entertain you with these papers. Carry that idea to its legitimate conclusion, and you will not be able to get a paper read before this Association. They are prepared to be read before us and received by us; that is why your committee send out its "for God's sake" letters, begging gentlemen to prepare these papers in order to fill out a programme and make up an interesting meeting; and simply because the member who prepares one of the papers says something that does not set good on somebody's stomach, it has got to be expunged. I move you now, that the paper of Mr. Monjeau, notwithstanding its length, and digressions from the pertinent subject in hand, have a place in our report with the others.

Mr. Espy—I would like to ask if the Executive Committee examined this paper before it was presented. It puts me in a rather unpleasant position. I would like to ask whether the paper was examined.

The Presiding Officer—It is the habit of the Committee to examine papers if the papers are presented in time. It is not usual, however, for the papers to be presented to the Committee before they are read.

Mr. Monjeau—In order to avoid further taking up the time of the Association, and debarring gentlemen who will entertain and instruct you better than I, allow me to withdraw that paper. (Cries of "No; No.") I beg your pardon if you will allow me one moment. I do not know the name of the gentleman who has objected to my paper, but I hope he will forgive me the crime of being human, and consequently fallible. He alludes to

the question which some physicians still doubt: the fact of seed germs, or germs of disease. That subject I presented at Chicago two years ago, in the most forcible manner I yet have seen, and my paper was published in the proceedings of this Association without the least objection. In that article I brought forward the testimony of the intelligence of this globe. Now Mr. Linneen (pardon me for calling by name) kindly acknowledges that the paper was long. I am sorry that it was. I am very sorry that I brought it here at all. It is a difficult task to try to instruct an intelligent body of gentlemen like this. It is a difficult task to get together data to develop an interesting discussion, requisite to keep a body of men like this together and yesterday I heard repeatedly complaints that papers did not excite more discussion. Now here comes one, perchance, that excites discussion, and some gentlemen want to put it down. I sympathize with my friend from Iowa, Mr. Denman, whose paper has in the past been crowded out. Please excuse me for this time, and I will trespass upon your patience no more.

THE PRESIDING OFFICER—It is intimated that we continue without any recess. We have much business to be done, that is, so far as the reading of papers is concerned. We will therefore take up the next paper, which is by Mr. Charles B. Brush, on "Water Works Notes."

Mr. Brush read his paper as follows:

GATES ON FORCE MAINS.

BY CHARLES B. BRUSH.

A curious accident recently happened to the plant of the Hackensack Water Company. The main pumping station of the company is at New Milford, on the Hackensack river. From this station water is forced through two lines of mains, lying one on the east and the other on the west side of the Hackensack valley. One main is twenty inches in diameter, and fifteen miles in length from the pumping station at New Milford to the reservoir at Weehawken. The other line is twenty-four inches in diameter and sixteen miles long between these two points.

There are four pumping engines at New Milford. All of them are of the duplex, direct acting type, and were built by Henry R. Worthington. One of these pumps has a capacity of 10,000,000 gallons in twenty-four hours. This pump is, however, not quite ready for service. The next largest pump has a capacity of 5,000,000 gallons in twenty-four hours. Both of these pumps have the high duty attachment. The other two

pumps have each a capacity of 3,000,000 gallons in twenty-four hours and are of the ordinary low duty type. The two 3,000,000 gallon pumps are usually employed to supply the twenty inch main, and the 5,000,000 gallon pump to supply the twenty-four inch main. For convenience of operation, the by-pass or connecting gate at New Milford is usually kept shut, thus separating the twenty and twenty-four inch mains.

At 8 p. m. on May 3rd, 1892, the rod, connecting the water plunger with the cross head of the compensating cylinders, on the south side of the 5,000,000 gallon engine and the cross head, together with the plungers in the compensating cylinders on the high duty attachment, broke simultaneously. At the time, the 5,000,000 gallon pump was forcing about 4,500,000 gallons per day through the twenty-four inch main under 102 pounds pressure, and one of the 3,000,000 gallon pumps was forcing 2,250,000 gallons of water per day through the twenty-inch main under ninety-one pounds pressure. Immediately after the accident occured the by-pass or connecting gate was opened and the second 3,000,000 gallon pump started, but to our surprise, we found that we were unable to force more than 3,500,000 gallons through both mains at 110 pounds pressure per square inch, where previously we had been supplying 6,750,000 gallons through these two mains under a much lower pressure.

The two lines of force mains were immediately examined. The air cocks showed no collection of air in the mains and the gates seemed to be all right. An inquiry into the pressure at the service pipes of consumers along the line of the force mains was then instituted which resulted in the discovery that between two adjacent localities, there was a marked difference in the pressure obtained from the same main. As this could only result from something being wrong at the gate on the main between these localities, it was decided that the trouble must be with this gate. The gate is a verticle one, having two discs attached to the valve stem, and it is operated in the usual manner. When the gate was taken apart it was found that the lugs which connected the discs to the stem had broken off, and the discs had dropped to the bottom of the gate. This closed the entire opening in the twenty-four inch main, while under a pressure of over 100 pounds per square inch.

The shock or strain that was thus suddenly brought upon the engines and the mains can only be imagined. The curious thing about it, and what puzzled us, was, that as far as could be ascertained by closing and opening of the gate, it seemed all right. This was probably due to the fact that one disc of the gate still remained attached to the stem and could be moved up and down by the valve stem, although, of course, it had no effect on the flow of the water after the other discs had dropped down into the socket of the gate. Fortunately for the water company, the rod connecting with the compensating cylinders on one side of the engine, together with its cross head and attachments, gave way under the excessive strain so suddenly brought upon them by the stopping of the flow of water, and as the mechanism for operating the steam valves of the other cylinders is attached to this cross head, the steam valves remained unopened, and the engine instantly stopped of itself. If it had not stopped, the mains must certainly have been ruptured.

As above stated, the break occurred at 8 p. m. on May 3rd. The Worthingtons were immediately notified and at 5 p. m. on May 6th, the broken parts had all been replaced and the engine was again running in good order, and it has been in satisfactory operation since that time.

Most of the gates on our force mains are horizontal, geared gates. The gate in question was placed vertically because the pipe was at that point at a considerable depth below the surface of the ground. The result of our experience in this matter, however, has convinced us that large vertical gates on force mains are undesirable.

In this connection, it may be pertinent to say that the location of gates on force mains should be on summits rather than, as is usually the case, in depressions. Gates require and should receive constant attention, and this attention is much more readily given, and in fact, generally only can be given when the gate is free from water pressure on either side. The water pressure is always relieved more easily from summits than from depressions. This fact may seem self evident and hardly worthy of consideration, but if it is not considered, a large amount of unnecessary time, labor and money may be wasted.

In the design of well constructed pumping engines, it will be admitted by designers and manufacturers of pumping machinery, many of whom are present at this meeting, that there must be considered not only the features essential to the proper operation of the machine when working under normal conditions, but there must also be provision made, so far as possible, for contingencies which may occur in the daily routine of service; such contingencies as would result in serious damage to the machine if special provision were not made to reduce the damage to a minimum, or eliminate it altogether. In other words the machine must not only be prepared to operate aggressively, but also upon the defensive. Provision for this latter performance has been given a great deal of study by manufacturers, and has been handled in various ways.

THE PRESIDING OFFICER.—The paper is now open for discussion.

Mr. Linneen moved that the paper be received and published in the proceedings. Carried.

MR. FULLER.—I would like to ask the gentleman one question, and perhaps he stated it; if he knows what the pressure was at the pumps when the break occurred.

MR. BRUSH.—102 lbs on one, and 90 lbs on the other. The mains were separate but had a connecting gate.

MR. FULLER.—That is the ordinary pressure?

MR. BRUSH.—Yes sir.

MR. FULLER.—When the gate separated, and one part dropped, did the pressure increase, and do you know how much?

MR. BRUSH.—The recording pressure gauge was not on at the time.

MR. WAGNER.—I desire to ask whether the accident would have happened if it had been a single wedge valve.

MR. BRUSH.—I desire to say that a vertical gate is undesirable. It can drop and close the main. It is impossible for this to occur with a horizontal gate.

MR. BOND.—I wish to ask the gentleman, in advocating horizontal gates, whether he has any trouble with other material collecting in the groove and preventing the gate closing?

MR. BRUSH.—As I have said, the force mains are about thirty-one miles long, with a gate about every mile, and nearly all the gates are horizontal. We have no more difficulty with the horizontal than we have with vertical gates. We have many different kinds on our works, my experience is that the most troublesome thing connected with gates is to make them water tight.

MR. LINNEEN.—I think horizontal gates and horizontal pumps ought to be put on the same footing. (Laughter.)

MR. BRUSH.—The gentleman wished to make a point, and he has evidently succeeded.

MR. LINNEEN.—I had just the same experience, only in my case it was under 265 lbs. pressure instead of 102, but there was no broken engine.

The next paper is by Mr. A. L. Metz on "The Water Supply of New Orleans." The Secretary read the paper as follows:

THE WATER SUPPLY OF NEW ORLEANS.

BY A. L. METZ.

"Where love is, there is no labor; and if there be labor, that labor is loved."—*Austin.*

Although overtaxed with work, of which our mutual and genial friend Mr. L. H. Gardner is well aware, I have, mindful of the above quotation, assented to his request to prepare a paper to be read at your meeting. On account of the haste in which the same has been written, I appeal to your leniency, in order that it may not be judged too severely or criticized too harshly.

The subject of this paper is : "A few words regarding the water supply of the City of New Orleans."

The sources of supply are :

1st. Rain water.

2d. Ground water. { Shallow or surface wells. / Artesian or deep wells.

3d. River water.

Notwithstanding the fact that the great Mississippi river flows by our doors, the chief dependence of the people for their water supply, is the rain water collected from roofs, and may add, that this water is used almost exclusively by the majority of our people.

The objections to the use of rain water, as collected and stored are many; the writer is however content to call your attention to a few of paramount importance.

1st. The collected water is stored in cisterns which will hold (on an average) 2,000 gallons. The falling rain washes impurities from the atmosphere, and soot, inorganic and organic material from the roof. The organic matter consists of comminuted manure, (the microscope revealing the epidermis of hay, straw, etc.) excremental matter from birds, decayed and decaying leaves, and mosses, dead insects, and such other substances as constitute the dust of a great city.

The precautions sometimes employed to mitigate the befoulment of cistern water, are the periodical cleaning of cisterns and the use of "cut-offs"; these precautions do not give the satisfaction intended; Why? The cleaning of cisterns, to be effectual, would have to be done after a rain, which is impracticable; but, admitting that it was practicable, would the cleaning of a cistern deprive the waters of the impurities that are most dangerous? decidedly not; we would only rid the cistern of its grosser particles which form the sediment, leaving in suspension the finer comminuted material to macerate, undergo decomposition and befoul the water.

Cut-offs require personal attention, (notwithstanding assurances from inventors to the contrary) this attention cannot be given at all times, especially during the night. The use of cut-offs are all right in principle, but practically they perform the work claimed for them, to only a limited degree. The writer has not seen a single one of the numerous devices called cut-offs, that prevented to any considerable extent the ingress of debris into a cistern. This is readily understood, the dust which is wafted upon the housetops, by traffic or wind during the day, becomes moistened by dew at night, forming what may in all respects be called a mud. This mud is baked by the rays of the sun, and this is kept up for days, weeks, and even months, until a layer of considerable thickness is formed, (the writer has seen it about ½ inch thick) which would require a heavy rain, and one falling for several hours to effectually put the roof in a condition to be the medium of a collecting surface. As a matter of fact, cut-offs work well for the first half hour, after which all the water with the accompanying impurities, already mentioned find entrance into the cistern.

2d. The writer has recently shown in a report upon water, presented to the Honorable Board of Health of the State of Louisiana, that the *location* of a cistern and its proximity to privy vaults had much to do with the sanitary condition of the water. As a rule, cisterns are located

in inclosurss, with anything but sanitary surroundings; in many instances but a few feet from the privy flue or door.

The privy system of this city is so well known, that it would be superfluous to go into details; suffice to say, that it is a vault containing a mass of reeking, putrefying, decomposing filth. The writer contends that wherever and whenever decomposition takes place, whether putrefactive or fermentative, the escape of gas during such process is always accompanied by an atomization of particles of whatever nature these may be.

The great absorbing power of water is well known to all, and it stands to reason that cisterns in close proximity to vaults, must of necessity absorb gases, and dissolve the minute particles, that are carried upwards by draughts of air, and deposited on the surface of the water. This assertion is fully demonstrated by the fact, that records exist proving that typhoid fever has been produced by the drinking of cistern water.

3d. Quantity. The receptacles for holding cistern water have not sufficient capacity, and very few cisterns can withstand the demand on them for thirty days during a drought. The periodical droughts which occur here, only too often, compel the people to witness the sight of our poorer laboring class who live away from water works mains, using gutter (or open sewer) water for domestic purposes.

SHALLOW OR SURFACE WELLS.

All the shallow or surface wells in the city, especially when on the premises of bakeries, have been interdicted by the Board of Health. An examination of these wells shows that the water from them is little better than sewerage. In other words, these surface wells are draining a soil saturated with nastiness.

ARTESIAN WELLS.

The necessary conditions for an artesian well are, that different geological strata should alternate with each other; *i. e.*, a water bearing or pervious stratum between two strata impervious to water.

The pervious strata should be continuous and of sufficient exposure to collect the supply with substantially water tight beds over and under, to prevent escape in a vertical direction. The water drawn from the stratum is constantly replenished by renewed precipitation of rain and the flow remains much the same, varying little, provided that too many wells are not bored in the same water bearing stratum.

The strata spoken of, should not lie horizontally, they should have sufficient dip or incline so that the water enters at a higher level than the site of the well, which condition will cause the water in the well to be forced above the level of the ground.

The elevation to which water will be forced from an artesian well, will be the height of the supply, less the diminished height, due to less pressure from loss of supply through fissures, the great amount of friction of the underlying beds, and the resistance of the atmosphere.

A condition which will also cause the water of deep wells to rise above the surrounding surface, is due to the expansive force of pent-up gases. This last condition is the cause of the overflow of our so-called artesian wells. The gas liberated is chiefly marsh gas.

The conditions for artesian wells do not exist in the city, except it

be at very great depths. The soil for several hundred feet is of a permeable character, which is super saturated with the drainage of thousands of privies, which have existed for many many years.

RIVER WATER.

From analysis made of filtered and unfiltered Mississippi river water, analysis of the former give results, that at once commend it as being the purest water available, in this city, under present existing circumstances.

It appears from analysis that much of the albumenoidal ammonia, and ammoniacal salts, are occluded in the sediment, as the writer cannot account for the diminished quantity of these substances in filtered river water in any other way.

THE PRESIDING OFFICER.—Gentlemen, the paper is before you; what is your pleasure in the matter?

MR. MILNER.—I move that the paper be received and the thanks of the Association returned to the writer;and that the Secretary be instructed to write a letter returning the thanks of the Association. Carried.

MR. JONES.—A gentleman here, Mr. Donahue, has a very short paper that will take about five minutes to read. It is a voluntary paper. I move that Mr. Donahue be heard.

The motion was put and carried.

Mr. Donahue then read his paper.

COMBINATION SYSTEM OF METER RATES.

BY JAMES P. DONAHUE.

The schedule of meter rates adopted by the most water companies and water departments, known as the sliding scale system, does not seem to be altogether satisfactory, and in many cases is the cause of much misunderstanding. It is oftentimes unfair to the water works and consumer alike. It is often an invitation to the consumer to open wide his taps to bring his consumption of water to the point where the rate per thousand gallons reduces, thereby decreasing his water bill, and causing loss to the Water Works of both revenue and water.

For illustration I take the following actual account from the books of a water company.

The schedule of water rates in this case being as follows :

For a consumption of 100,000 gallons or less per month, rate 30 cts.

For a consumption of 100,000 gallons to 250,000 per month, rate 20 cents.

For a consumption of 250,000 gallons to 500,000 per month, rate 15 cents.

For a consumption of 500,000 gallons and over per month 10 cents.

In August consumption was 702,732 gallons at ten cents, amount paid $70.27. In October consumption was 496,125 gallons at 15 cents, amount paid $74.42 thus, $4.15 more was paid for a consumption of 206,607 gallons less. In May consumption was 535,275 gallons at 10 cents, amount paid $53.52. In October consumption was 496,125 gallons at 15 cents, amount paid $74.42, or in May $20.90 less was paid for a consumption of 39,150 more gallons of water than was used in October. Now had the consumer opened his taps in October and permitted 3,876 gallons to have gone to waste, his consumption would have reached 500,001 gallons and he would have been entitled to the 10 cent rate and his bill would have been $50.00 instead of $74.42, or an actual saving to him of $24.42 in one month's water bill. This is but a simple illustration of what has made itself apparent in the experience of Water Works men. In the schedule of rates given above the change from one rate to another is of course too large and permits of too great a variation, but I mention same as an actual occurrence. Rates of this kind scales down but a cent or two per thousand for each five or ten thousand additional gallons used making it more equitable, but the unfairness of this system of rates is still plain.

There also exists that inequitable scale of prices objected to by many classes of consumers. For example, Consumer A, B, and C meet; A will say that he is paying ten cents per thousand gallons for the water he uses, B says he is paying 20 cents, and C will say that he is paying 40 cents. Then will follow a full discussion of the unfairness and discrimination of the Water Works, and brings forth the fact that it practically costs the Water Works as much per gallon to pump 200,000 gallons used by A, as the 20,000 gallons used by B, and that the Water Works in their eyes have no right to make wholesale and retail prices. That A should get his water cheaper than B, is not equity or fairness. On the other hand the Water Works managers are strong in their position maintaining and justly too, that the rates are for wholesale and retail consumption and sale of water. That a man cannot go into a grocery store and buy or expect to buy 20 pounds of sugar, salt or anything else at the same rate per pound that he could buy 20,000 pounds for. The feeling of dissatisfaction, of unfair discrimination however, still exists in the minds of the smaller consumer. Some years ago the *Engineering News* brought out a new system. I am not now able to trace the article, but it was the same system that was adopted by the Memphis Water company. In this system a different rate is made for each 5,000 gallons up to 50,000 gallons, and then a new rate for every additional consumption of 50,000 after carrying out the amount of each of these different charges into a column they are all added together and thus the bill is made out. This was certainly a step forward in the way of getting a more equitable bill, but it makes a complicated account and requires more or less explanation until one gets accustomed to the system, and to me it does not seem to be just the thing that water works men want. This is evidenced by the fact that the system has been before them many years and so far but one company has seen fit to adopt same.

To treat the small and large consumer alike and give them the same proportionate rate per thousand gallons of water used has led me to study out the following combination of meter rates.

Following will be found six meter tables, although many more can

be compiled. These six tables seem to cover the rates in general use by different water companies. A water department is supposed to adopt but one of these tables and use but one.

The system comprises a fixed charge per thousand gallons for a fixed quantity of water and a fixed rate for each thousand gallons used in excess, the rate to apply to all classes of consumers alike. The tables are compiled to illustrate how the rate scales itself down as the quantity used increases. It is necessary to use the tables in making out meter bills, for one peculiar feature in this system is that all bills can be computed mentally, thus avoiding the necessity of a good deal of figuring when making out meter bills, and it is so simple that it is almost impossible for one to make a mistake in computing a water bill.

If a company should decide to adopt Table No. 1, the rate for a consumption of 30,000 gallons or less per month would be 30 cents per thousand gallons, and all used in excess would be at the rate of ten cents per thousand. Should the Water Works find that the rate is not high enough, then Table No. 2 gives a rate at a little higher percentage and so on, each table at a little higher rate. I will illustrate by taking a consumer using 60,000 gallons per month his bill would be under the different tables as follows :

TABLE NO. 1.

Rate 30 cents per 1,000 gallons for 30,000 gallons per month, 10 cents per 1,000 for excess.

30,000 gallons at 30 cents per 1,000,	$9.00
30,000 gallons at 10 cents per 1,000,	3.00
60,000 gallons	$12.00 Average rate of 20 cents per 1,000.

TABLE NO 2.

Rate 30 cents per 1,000 gallons for 35,000 gallons per month, 10 cents per 1,000 for excess.

35,000 gallons at 30 cents per 1,000,	$10.50
25,000 gallons at 10 cents per 1,000,	2.50
60,000	$13.00. Average rate of 21.6 cents per 1,000.

TABLE NO. 3.

Rate 30 cents per 1,000 gallons for 40,000 gallons per month, 10 cents per 1,000 for excess.

40,000 gallons at 30 cents per 1,000,	$12.00
20,000 gallons at 10 cents per 1,000,	2.00
60,000 gallons	$14.00. Average rate of 23.3 cents per 1,000.

TABLE NO. 4.

Rate 40 cents per 1,000 gallons for 30,000 gallons per month, 10 cents per 1,000 for excess.

30,000 gallons at 40 cents per 1,000,	$12.00
30,000 gallons at 10 cents per 1,000,	3.00
60,000 gallons.	$15.00. Average rate of 25 cents per 1,000.

TABLE NO. 5.

Rate 40 cents per 1,000 gallons for 35,000 gallons per month, 10 cents per 1,000 for excess.

35,000 gallons at 40 cents per 1,000,	$13.50
25,000 gallons at 10 cents per 1,000,	2.50
60,000 gallons	$16.00. Average rate of 26.6 cents per 1,000.

TABLE NO. 6.

Rate 40 cents per 1,000 gallons for 40,000 gallons per month, 10 cents per 1,000 for excess.

40,000 gallons at 40 cents per 1,000,	$16.00
20,000 gallons at 10 cents per 1,000,	2.00
60,000 gallons	$18.00. Average rate of 30 cents per 1,000.

COMBINATION TABLE OF METER RATES.

Consumption per month.	TABLE NO. 1. 30c pr 1,000 for 30,000 10c for Ex.	Actual Rate per 1,000.	TABLE NO. 2. 30c pr 1,000 for 35,000 10c for Ex.	Actual Rate per 1,000.	TABLE NO. 3. 30c pr 1,000 for 40,000 10c for Ex.	Actual Rate per 1,000.	TABLE NO. 4. 40c pr 1,000 for 30,000 10c for Ex.	Actual Rate per 1,000.	TABLE NO. 5. 40c pr 1,000 for 35,000 10c for Ex.	Actual Rate per 1,000.	TABLE NO. 6. 40c pr 1,000 for 40,000. 10c for Ex.	Actual Rate per 1,000.
30,000	9.00	30.0					12.00	40.0				
35,000	9.50	27.1	10.50	30.0			12.50	35.7	13.50	40.0		
40,000	10.00	25.0	11.00	27.5	12.00	30.0	13.00	32.5	14.00	35.0	16.00	40.0
45,000	10.50	23.0	11.50	25.5	12.50	27.7	13.50	30.0	14.50	32.2	16.50	36.5
50,000	11.00	22.0	12.00	24.0	13.00	26.0	14.00	28.0	15.00	30.0	17.00	34.0
55,000	11.50	20.9	12.50	22.7	13.50	24.5	14.50	26.3	15.50	28.1	17 50	31.8
60,000	12.00	20.0	13.00	21.6	14 00	23.3	15 00	25.0	16 00	26.6	18.00	30.0
65,000	12.50	19.2	13.50	20.7	14.50	22.3	15.50	23.8	16.50	25.3	18.50	28 4
70,000	13.00	18.5	14.00	20.0	15.00	21.4	16.00	22.8	17.00	24.2	19.00	27.1
75,000	13.50	18.0	14.50	19.3	15.50	20.6	16.50	22.0	17.50	23.3	19.50	26.0
80,000	14.00	17.5	15.00	18.7	16.00	20.0	17.00	21.2	18.00	22.5	20.00	25.0
85,000	14.50	17.0	15.50	18.2	16.50	19.4	17.50	20.5	18.50	21.8	20.50	24.1
90,000	15.00	16.6	16 00	17.7	17 00	18.8	18.00	20.0	19.00	21.1	21.00	23.3
95,000	15.50	16.3	16.50	17.3	17.50	18.3	18.50	19 4	19.50	20.5	21.50	22.6
100,000	16.00	16.0	17.00	17.0	18.00	18.0	19.00	19.0	20.00	20.0	22.00	22.0
125,000	18.50	14.8	19.50	15.6	20.50	16.4	21.50	17.2	22.50	18.0	24.50	19.6
150,000	21.00	14.0	22 00	14.6	23.00	15.3	24.00	16.0	25.00	16.6	27.00	18.0
175,000	23.50	13 4	24.50	14.0	25.50	14.5	26.50	15.1	27.50	15.7	29.50	16.6
200,000	26.00	13.0	27.00	13.5	28.00	14.0	29.00	14.5	30.00	15.0	32 00	16.0
250,000	31.00	12.4	32 00	12.8	33 00	13.2	34.00	13.6	35.00	14.0	37.00	14.8
300,000	36.00	12.0	37.00	12.3	38.00	12.6	39.00	13.0	40.00	13.3	42.00	11.0
400,000	46.00	11.5	47.00	11.7	48.00	12.0	49.00	12.2	50.00	12.5	52.00	13.0
500,000	56.00	11.2	57 00	11.4	58.00	11.6	59.00	11.8	60.00	12.0	62 00	12.4
600,000	66.00	11.0	67.00	11.1	68.00	11.3	69.00	11.5	70.00	11.6	72.00	12.0
700,000	76.00	10 8	77.00	11.0	78.00	11.1	79.00	11.2	80.00	11.4	82.00	11.7
800,000	86.00	10.7	87.99	10.8	88.00	11.0	89.00	11.1	90.00	11.2	92.00	11.5
900,000	96.00	10.6	97.00	10.7	98.00	10.9	99.00	11.0	100.00	11.1	102.00	11.3
1,000,000	106.00	10.6	107.00	10.7	108.00	10.8	109.00	10.9	110.00	11.0	112.00	11.2

THE PRESIDENT—The paper is before you for discussion.

MR. RICHARDS—I would like to say in regard to Mr. Donahue's schedule of rates, that some of the gentlemen here think they are not arranged correctly. I think he should make the large consumer run through that scale: first 400,000 gallons, fifteen cents; next 400,000, thirteen cents; next twelve, and so on. We have large consumers. We use a rate arranged in that way; so that our largest consumer, although our rate runs down to six cents, pays on an average twelve cents. He pays through the whole schedule. The man who uses 400,000 gallons pays fifteen cents for the 400,000, and the man who uses twice that amount pays fifteen cents for the first and thirteen cents for the next 400,000, so that he pays through the whole scale. The fact that Mr. Donahue speaks of, that the large consumer can lessen his rates by allowing a large quantity of water to run away, is true; so we make him pay through the whole scale, which will overcome that inclination.

MR. BENZENBERG—We have a rate on a graduated scale similar to that recommended by Mr. Donahue. It has this advantage, that every consumer, great or small, for the first 25 000 cubic feet consumed in the year, pays the same rate. It does away with the argument that the larger consumer is favored as against the smaller. We charge for the first 25,000 cubic feet a rate of fifteen cents a hundred; the next at the rate of ten cents, and gradually get down to three and one-half cents, where it exceeds 500,000 cubic feet a year. Since adopting this rate, we hear less of the annoying argument that the small consumer will produce, that he is discriminated against on account of the larger consumer. They all pay the same rate—the large consumer pays as much for the first 25,000 cubic feet as the small consumer. I think it is a good system to inaugurate in any place; and scale it so as to meet the prices you are actually giving them their water for at the present time. It does away with the argument referred to.

THE PRESIDENT—Mr. Donahue's paper is a surprise to me. I did not suppose there was any system in vogue

except the one described by Mr. Benzenberg, which seems to be the only fair one.

Mr. Page—I certainly have been edified by this discussion. I revised my meter rates some two years ago, and I thought I was doing very well in copying from large cities, but I had an endless amount of kicking and had about determined to abandon the prorated table, which was about as follows: "The first 10,000 feet was ten cts. per 100 feet and the second 10,000 feet was five cts. per 100 feet, and we would just figure his entire bill by his maximum consumption, and it would be ten dollars either way, whether he used 10 or 20,000 feet, but now I see the rates were all right, but I was all wrong in making out the bill, which should be 10 cts. for first and 5 cts. for second 10,000, making fifteen dollars for 20,000 cubic feet.

Mr. Wanner—On this subject of meters, I would just say that I was rather surprised that it had not been brought up before. I can say this—that I was agreeably surprised when coming to this meeting to see the progress that has been made in that direction. It is only within the last few years that competition has brought out a great many manufacturers and reduced the cost of meters. Heretofore it was supposed that the price of water-meters was so high that their general use would be prevented. When I came here I noticed that some were down as low as nine dollars and a half. In my opinion, there is a great field in that line; and that it will only be a matter of time when water meters will become as general as those for gas. I thought it might be a proper thing to bring up this matter, and, before leaving home, had a resolution drawn up for the appointment of a committee to investigate the subject and report at the next meeting, but I feel now that it might, perhaps, stir up some feeling among the competitors, and yet I wish to submit whether it would not be a good thing to have a committee appointed to investigate the relative merits of the various meters, as to practicability and cost, and report at the next annual meeting of this Association.

Mr. Linneen—The subject that Mr. Donahue has sprung upon this Association has darkened the atmos-

phere here to such an extent that I would like to have a little light thrown on the subject. I shall be opposed to the resolution suggested by my friend. We do not want any committee of this Association to pass on this question which is the worst or which is the best meter. Every water works man must determine that in his individual capacity.

Mr. John—I want to tell you how we manage the meter question in our town. We are young in business, and have never sold water in large quantities. We sell water at fifty cents a thousand gallons. We read our meters every three months, and in a bill of five dollars, we make a discount of ten per cent.; ten dollars, twenty per cent.; fifteen dollars or over, thirty per cent. I think that is the better way of getting your rate than going down the hill on the scale.

Mr. Dunham—If in order, I will say that at the request of the President, I prepared a short paper for this meeting and would like permission to have it read by title, that it may occupy no further time. If in order, however, I would like your attention for a minute, to a miscellaneous matter that has been weighing upon me a little, and that I will mention from a sense of duty. It has been two years since I was at a meeting of this Association, and in the interval I have been present where bids were canvassed for water works, and the parties anxious to dispose of different kinds of water works' material, brought before the mayor and council to present their models and letters of reference. In one instance, a gentleman after exhibiting a number of letters, threw down one remarking, "And now I want you to see how the American Waterworks Association regards the goods I offer." After others had read the letter, I expressed a little interest, picked it up and found it was written upon a letter-head of this Association and that it was a hearty endorsement of the goods the gentleman had offered for sale, and at the bottom there was the name of one of the officers of the Association, and following the name, the same official title that appeared above the name at the top of the page. I was much astonished. I hope a mere mention of the facts here will be sufficient to prevent anything of the kind from ever

occurring again. The letter-heads of this Association should be locked up. I would like to mention a pamphlet sent out, I believe, by Robert W. Hunt & Co., of Chicago. I intended to bring a copy with me. They are inspectors by the title page of their pamphlet, and introduce themselves upon the first page in this manner: "Cast-Iron Coated Water Pipe. Specifications for its Manufacture Adopted by the American Water Works Association, at its meeting held in Philadelphia." The pamphlet contained a report that was presented to the Association, and very likely adopted. But it would seem that Robert W. Hunt & Co. should join some benevolent society where they would learn that the adoption of a report in regard to an orphan, is a different thing from the adoption of the orphan. (At any rate, they should not make unfair or improper use of the proceedings of this Association.

THE PRESIDENT—I will read the resolution referred to: "Resolved, that it is the *sense* of this convention that the form of specifications for cast iron pipe reported by this committee is the proper and correct form to use in all proposals for cast iron water pipe." It was not an adoption of the report. It was merely an expression of the sense of the convention that that was a proper form.

MR. WAGNER.—I have come here this year as I did last, on a mission of information. The rapid demand for water in our city causes us to abandon the present supply and draw our supply from the river, which will necessitate filteration. Not having had any experience in filteration I would like to meet any of the members of the Association who have had any experience in gravity and pressure filtering.

MR. LINNEEN.—I will say, for the information of the gentleman, if he will produce a bottle of whiskey and a box of cigars that Col. Donahue will meet him.

MR. WAGNER.—I may say I am perfectly willing to meet him with the cigars, but I furnish water.

MR. DONAHUE.—I would like to say that as I come from the great state of Iowa, I feel in conscience bound to drink nothing but water.

On motion adjourned until 3 o'clock.

Afternoon Session.

The President called the meeting to order at 2:40 o'clock and announced the first order of business to be the paper by Mr. Peter Milne on "Water Pressure and Water Distribution." Mr. Milne read his paper, as follows:

PRESSURE AND DISTRIBUTION.

BY PETER MILNE, HYDRAULIC AND SANITARY ENGINEER.

A constant figure of head or pressure is easily maintained in a distributing reservoir or stand-pipe, where a reserve exists above the daily requirements of draught incident to the system. As daily consumption increases, the reserve force or power is reduced proportionately. Loss of head due to draught is determined by the measure of time taken to accomplish it. The greater the length of the measure of time taken to discharge a given quantity of water, the greater the efficiency of the pressure during that length of time.

The philosophy of a system of distribution is, to preserve its dynamic energy rather than to permit its abuse; this element of power is constantly under the influences that in themselves seek to impair the efficiency and durability of all water works plans of distribution. The initial efficiency of a system of distribution is no evidence of its durability. There is no safety in simply being able to supply a system, the plan should in its original conception provide a reserve equal to compensate for a legitimate use of the dynamic energy of the plant as the daily demand and consumption of water increases. The trunk mains leading from distribution reservoir or stand-pipe, and under a constant head or pressure, due to a constant height of water in either reservoir or stand-pipe, is the full measure of the efficiency of the plant. The system of distribution connected to the trunk mains together with the service pipes leading into dwellings, factories, warehouses, stables, etc., are the influences that operate and seek to deteriorate the efficiency. These influences according to their collective ability and opportunity determine the velocities and accelerations of them in the water mains of the several districts of distribution. As the system of distribution is lengthened and more services are daily added to it, the reserve in the form of constant head is attacked and it can be no longer maintained, pressure is impaired and water ceases to flow in the high altitudes of the system of distribution. This is simply an illustration of the history of water works in American cities. The remedy need not here be alluded to which of necessity must be adopted, viz.:—construction of larger works in form of new reservoir, new pumps and new trunk mains, with all of the accessories.

The term of durability and efficiency of water works is determined by the methods of its administration regarding the details and consummation of the plan of distribution in the essential and vital features of space, time and velocity.

Space refers to area of cross section of tap driven into the water main, which of course determines the velocity of discharge and the time it takes. A line of discrimination may be established with reference to

size of taps, which can in safety be determined according to pressure on the several variable planes of delivery. The throttling of gates controlling lines of distribution on low levels is not a safe practice in the event of fire service being needed. The restriction in size of tap is better, it simply prolongs the time of the delivery or discharge of water. The impairment of fire service is largely due to excessive draught occasioned by a too liberal consideration of the size of taps permitted for house service. In all well matured plans of distribution the following characteristics appear in the calculation: First, a constant pressure due to depth of water in distributing reservoir, stand-pipe and direct pumping system; second, a trunk main or mains equal in cross-section of area to the aggregate cross-section of branches leading from them into the system of general distribution; third, that the size of taps be kept down to the lowest possible cross-section of area consistent with a reasonable discharging capacity during a reasonable length of time. In no respect does the small tap driven into the main diminish the quantity of water used and wasted, but the time of delivery being extended, the energy of the pressure is consumed and manifested by the fact that a greater number of small taps can be served under the same pressure than a less number of large ones, the aggregate cross-section of area being the same in both instances, for the obvious reason that the differences in velocity has lengthened the time of delivery in the case of the small taps compared with the time of delivery in the larger ones.

A supply of water in its features of general distribution involves an experience similar to a domestic house supply. The outlets of discharge in the low levels of the house frequently absorbs the entire pressure, and no water flows on high levels until the discharge ceases at the low levels. If the pressure be insufficient to discharge water at the high levels, it is apparent that a proper consideration of the area of cross-section of branch pipes, on the several levels of delivery, is neglected. A diminution of area of cross-section of branch pipes on the several levels, proportionate to the pressure at those points, will permit the water to discharge on all of the levels simultaneously.

The abuse and consequences attending systems of distribution has led some engineers to advocate high pressure systems in place of low pressure ones, and in order to overcome the difficulties apparent in low pressure. Experience, however, proves that even under more than moderate head or pressure, the trouble is just as liable to occur and does occur. The equalization of pressure in a system of distribution cannot be well attained where it is daily increasing its delivering capacity at different parts or portions of its territory, for in the nature of the topography of the city greater or less pressure may exist. Yet the fact is not to be lost sight of that the distinctive and variable features of the figures of velocity in distributing pipes of varied sizes and under varied pressure found in one system has perhaps been overlooked or has not been utilized to the extent that it might have been if careful study had been given it. An intelligent consideration of this question simply enlarges the view of possible and probable difficulties that are liable in the administration of many systems of distribution which in their original plan never contemplated the results that ensue from defective methods of reinforcement. It is, however, possible in several ways to overcome defective pressure provided it is demonstrated that there is more than enough in one dis-

trict and a deficiency in another district. It can be balanced by reinforcement and without detriment to either. In a comparatively level system of distribution a decided advantage is apparent compared with a hilly or undulating one. A wider range of variable pressure obtains in the last mentioned one.

A system of gauging pressures on trunk mains and on leading lines of distribution at the highest and lowest points, and in districts using large quantities of water, will furnish data of pressure at all hours of the day; and from these records one may be able to work out the actual loss of head due to draught, and determine if the same be excessive or otherwise. The importance of possessing this information cannot be overestimated, and it would seem as if not to have it, or not care anything about it, is the best possible evidence that the superintendent is a "back number" and his official associates are of a no later edition.

More could be said upon this subject, but it would simply be as to the advantages that would be obtained and gained, as suggested, by information which the writer claims is as much if not more valuable than any other information that could be obtained as to the local and general condition and also the weak and the strong points of the system of distribution. There is nothing in the wide realm of boundless activities that inspires one with courage and confidence to such a degree as a knowledge of what one is doing in the field of his work. It would seem as if in the course of progress and development of water works administration during the past ten years that there is a marked evidence in the way of improvement and results. In the dual nature and consideration of this subject is found to the delight of many an engineer and superintendent the success attending his efforts to prolong the dynamic energy of the plant by stopping waste of water. And it is not too much to say that the popularity and growth of the idea of the water meter used to save water, carried with it the inevitable result of a diminshed velocity compared with former experiences of water discharge, and consequently a restoration of pressure, thus supplementing the original plan of distribution to the extent of what may be saved not only in water, but in pressure which being restored by abridging waste, gave additional and increased efficiency to a hitherto impaired fire service.

THE PRESIDENT—Gentlemen, Mr. Milne's paper is now before you for discussion; are there any remarks?

MR. ESPY—I move the paper be received and a vote of thanks extended to the gentleman for his paper. Carried.

THE SECRETARY—Before you go to other business, I wish to say that I noticed in the case of all the papers read, with the exception of the first one entitled "Reservoir Dams," there has been a motion made to accept the paper and spread it on the minutes. That motion, of course, is entirely superfluous. The paper has been accepted when it is presented to the Association. Coupled

with this motion has been a vote of thanks, but as Mr. Rider's paper, the first one, was not the subject of a vote of thanks, I move that the thanks of the Association be tendered to Mr. Rider for his paper on "Reservoir Dams." Carried.

Mr. Espy—I noticed in a motion this morning that the Secretary was requested to write to the parties furnishing these articles, extending to them the thanks of the Association; and I think it would be well to do this in all cases.

The President—It is hardly necessary in the cases of gentlemen who are present.

Mr. Milne—Mr. President and gentlemen: It was my intention yesterday to express my views regarding certain experiences relative to the utilization of pressure at fire service. In talking with a friend he said to me: Perhaps it would be well for you to say something on the subject, in that it might be an opportune and timely suggestion to others. In many original plans for distribution the engineers fail to contemplate what may be required of the plant in the future. While the processes of argument and consultation are being carried on, the public suffer. Not a great while ago, in a city not a hundred miles from New York, a fire took place on Sunday, which is a day when pressures are a little more than normal—from the fact that all factories and mercantile establishments are shut down, and a marked restoration of pressure is apparent. Such is the experience of nearly all engineers, that a better pressure obtains on Sunday than on any other day, because there is less draught. This fire occurred in a building early on Sunday morning, and 26 hydrants were called into requisition, and the fire bid fair to be a conflagration of pretty wide extent. I happened to be familiar with the system of distribution and was called upon by one of the executive officers to know why it was that an efficient fire service was not rendered on that occasion. I went to the scene of the fire. It was easy to ascertain that there was a defective pressure. The question was how to overcome the difficulty. I do not know how many fire hydrants they were feeding; but there were 26 in operation. At all events,

there were not over three or four effective streams emanating from the engines. I simply put my foot on one of the suction lines and said to the district engineer, that engine is useless; as nearly as I can recollect you can profitably use 16 fire hydrants instead of 26. The result was that 10 of the hydrants were shut down and the 16 remaining gave efficient fire service. Gentlemen, it is not expected that the ordinary firemen comprehend the relative dual relations existing between pressure and distribution; and it has seemed to me that it is an opportune time for each superintendent to confer with his district engineer as to the propriety of using certain numbers of hydrants in his district. That is prior to the idea of reinforcement. Of course, every water works superintendent realizes and knows of the weak spots in his distribution. He knows where they exist. He must control them, and utilize the efficient strength of his system to the best advantage until such time as reinforcement comes. You know what reinforcement means. The 16 hydrants that I speak of did efficient service and extinguished the fire, which involved a loss of over a million dollars, but which might have been five million, had not that suggestion been made. The firemen fail to consider these relative questions involved in the quantity of water that can be delivered per minute or second through a fire hydrant through a certain length of pipe under a certain pressure. It is an easy matter for a superintendent of a water works to subdivide his district of distribution, and say to the fire department, that is all the water you can get satisfactorily out of a fixed number of fire hydrants under the present plan of distribution.

Mr. Gardner—Do I understand Mr. Milne to say that there are circumstances under which three steamers will do more effective work than six?

Mr. Milne—Yes, sir.

Mr. Dunham—I have had a little experience that tallies closely with that of Mr. Milne, but where the pressure was furnished directly from the pumping machinery. The fire was quite a large one, and two or three lines of hose were first used, with small nozzles, and then lines of hose laid to hydrants that were a longer

distance away, and additional streams used, and the pressure was very unsatisfactory; when the total amount of water that was necessary to put out the fire might have been taken by the use of the short lines of hose and large nozzles. Their method was faulty, and the results were unpleasant and everybody dissatisfied. There was nothing wrong in the conditions, so far as the machinery, the mains and the hydrants were concerned. The difficulty was in not attaching to the hydrants proper lines of hose, with proper nozzles that would give good sized streams, instead of having a large number of small openings, and getting unsatisfactory pressure.

THE PRESIDENT—This completes our regular list of papers, and not one on the list has been missing. I believe Mr. Dunham wishes to present a paper and we will be glad to hear from him.

MR. DUNHAM—I said this morning that I would read my paper by title only. I presume if I had known there was to be an afternoon session I would not have been willing to dispose of my paper quite so quickly. It is very short, and with your permission I would like to read a part of it.

THE PRESIDENT—If there is no objection, Mr. Dunham will read his paper.

Mr. Dunham read his paper on "Covered Reservoirs," as follows:

A COVERED RESERVOIR.

BY MR. DUNHAM.

It was not the writer's intention to present a paper at this meeting of the Association, and the merit, if there be any in this effort, should be credited to the report of the engineer of the Franklin, New Hampshire, water works, which contains a description of a covered reservoir, so ably written that it has awakened this feeble echo.

In the design for a water supply for Coshocton, Ohio, made in the spring of 1890, a covered reservoir was introduced, and the work carried out in the summer of that year. Some brief notice of the work has already appeared in the technical journals, but there is always a little matter of detail hitherto unpublished, which the fond designer can seize upon as an excuse for again shouldering his crutch.

The supply at Coshocton is from driven wells, making the necessity for a covered reservoir greater, although with any kind of water such covering might be regarded as desirable.

The reservoir is located upon a summit about one and three-fourths miles from the pumping station and at an elevation of two hundred and fifty feet above the city. The capacity was determined by the amount of the appropriation and its supposed relation to other features of the work—the pipe system, machinery, station, etc. The reservoir is circular in plan, fifty feet in diameter, and was placed at such an elevation with reference to the surface that the material excavated made the required embankments and covering.

The excavation disclosed four or five feet in depth of heavy yellow clay and the remaining fourteen to sixteen feet was of shale and hard sandstone in nearly horizontal layers, from an inch or two to one foot in thickness, with frequent vertical fissures and more or less fire clay. The cracks and seams were often two or three inches in width and it was evident the reservoir could only be made water-tight through the use of good material and by careful workmanship.

After the excavation was made and the twelve-inch supply and discharge main with gate put in place, a concrete floor four to six inches in thickness was laid down. That portion of the floor within a radius of twenty-two feet sloped toward the centre about one in six, to facilitate cleaning and give increased capacity at small cost. The circular wall was of sand stone, twenty-one feet in height in regular courses, fifteen inches wide, each stone a through stone and every end and horizontal joint accurately cut for its entire width and depth. The inside face was pointed or dressed to leave no projections exceeding one inch. It was also pointed with mortar, or should have been, as it was laid, and not a week or two afterward. The narrow space back of the wall was filled with concrete and mortar.

A skew-back course was provided and strengthened against outward thrust by an iron hoop, three-fourths of an inch by four inches in section, cut into the course and covered with cement to preserve it. Whether this iron band or hoop was of any particular service beyond causing a feeling of security the writer does not pretend to say, and does not believe it would at any time have been an easy matter to find out.

Upon the skew-back course there was erected a light framework or form of spherical shape. It was in fact that portion of a sphere having a radius of twenty-nine feet which would pass through or project above a circle fifty feet in diameter. The framework or center was sawed to a radius of twenty-nine feet. The principal rafters and the short cross-pieces to unite them at intervals were all cut to the same radius. When joined their outward edges were all in the surface of the sphere, although one might at first think differently. The frame was then roughly covered with boards one-fourth of an inch in thickness, to serve as a guide to the masons, and a brick arch or dome one foot in thickness was carried up to within thirteen feet of the center, there reduced to eight inches in thickness, and the work so closed in.

A man-hole three feet in diameter was built up to grade from a point on the dome about eight feet from the side of the reservoir. This was provided with a heavy iron cover. Very little weight came upon the framework during construction and the work might have been carried on without any centering, but with less convenience and rapidity.

To avoid staging for the masons the earth was scraped in against the brick-work as it was laid. A mule team was used in scraping, and before

the dome was finished one of the mules was found to be very sure-footed and to take a little pride in walking around close to the edge of the fresh brick-work. With scant knowledge of mathematics, great faith in Portland cement, and a confidence due to the behavior of the dome under a moving mule load, the writer believes it entirely feasible to construct such domes eighty or one hundred or more feet in diameter. This dome was covered with earth and sodded upon slopes of two to one. No wash-out pipe was provided for the reservoir. When necessary to clean it a gate will be closed in the delivery pipe and a blow-off opened through which the stirred-up and dirty water will be discharged, the city being supplied meantime by direct pressure from the pumps of two millions capacity. It may be objected that this will not leave the supply main in good condition, but more water can be flushed into and out of the reservoir until it is in good condition before any is used. An overflow was provided just above the skew-back course and another at an elevation of six feet above the first, with the intention of using the latter after the embankment had settled and become firm. The reservoir has been filled to this higher level without causing any trouble. The capacity to the skew-back course is 320,000 gallons and to the upper flow 350,000. The cost was less than $4,500, but it should have been more, for the site was almost inaccessible and all material was hauled up by an engine. The cost per thousand gallons was less than $13.00. This reservoir may be unique in the relation that exists between the quantity of masonry required to build it and the quantity of water it contains.

Covered reservoirs present new problems and the engineer may need the counsel of men in other professions. The botanist should tell him what to sow or plant on such reservoirs that will take up water enough through five or six feet of air space to keep green and thrifty without sending down roots enough to fill up a twelve-inch gate, as a willow tree would if placed within a hundred yards.

The meteorologist should be heard in regard to the proper height of a mast, size of conductor and disposal of the lower end of it, so that arches and piers in such exposed localities may not be tumbled into the bottom of the reservoir by a stroke of lightning.

And perhaps the chemist might suggest better methods for making such reservoirs water-tight. The one here described was scrubbed with two coats of cement and water, with good results but much labor. The ground water stored in covered reservoirs will usually contain carbonates, as shown by analysis. From such water under certain conditions, as in contact with carbonic acid gas, limestone is formed, and it might be asked what substance should be introduced when the reservoir was empty to find its way into all the interstices of the masonry, there to come in contact with the water and compel it to reinforce the sandstone with a limestone that would remain and be impervious, making the reservoir tight with slight expense for labor.

MR. FULLER—I am interested in this matter of covered reservoirs, because I had the pleasure of designing the one that has been spoken of at Franklin, N. H. Some of the ideas which have been expressed in this paper have occured to me; for instance the one of sur-

rounding the masonry wall with a band of iron to take up the thrust of the roof. I did not adopt it because I thought the wall strong enough. I had also the pressure of the earth embankment against the wall, and my reservoir was a little different from Mr. Dunham's. Instead of having one continuous dome, I had a central dome, with a span of twenty-four feet, and then two circular covering arches extending around it. It ocurred to me that it would be a very good idea to strap this central circular wall with a hoop or band of heavy iron, made so that it could be drawn up by nuts. This band would take up the thrust of the dome, and would be removed on the completion of the entire roof. I built mine by laying a continuous line of brick-work from the masonry wall on one side through the centre of the dome to the masonry wall on the other side, and then continuing the work on both sides of the centre in such a way that it should be on a straight line passing through the centre of the dome. As Mr. Dunham has said, a covered reservoir is, I think, accepted as the model form for ground water. I was much pleased with the ease with which the Franklin reservoir was built. There was no trouble in supporting the roof. The piers that I used were only a foot square, and about seventeen feet high. I thought at first they would be likely to get out of plumb, and cause trouble before we could put in the lintel arches which connect pier to pier. By using a little bracing we had no trouble, and after the piers were connected by the lintel arches, each pier braced itself. There is a cut of this construction in Engineering News for May 12th. If any of the members are interested, I would like to have them see some photographs I have, showing the course of construction. I think Mr. Dunham said the cost of his resevoir was thirteen dollars for each one thousand gallons of its capacity. The cost of his reservoir seems to have been less than mine. The capacity of my reservoir was 504,300 gallons, and the cost per thousand gallons was eighteen dollars. A covered reservoir has recently been built at Newton, Mass., of rectangular shape, which has a capacity of 2,500,000 gallons and cost, I believe, about eighteen dollars per thousand gallons.

Mr. Jones.—Some one has asked why the reservoirs are covered.

Mr. Fuller—With us in the East, especially in New England, a great deal of ground water is used; that is, we get our supplies either from dug or driven wells. When that water is exposed to the sun and heat in an open reservoir, there is often times a good deal of trouble from the growth of algae, which seems to find its proper food in ground water, which contains in solution various mineral salts, and the result is a considerable vegetable growth. If this water can be stored in a dark reservoir, away from light and heat, there is no trouble, no growth whatever, and the water is perfectly clear. We have many open reservoirs in connection with ground water supplies, and in the middle of Summer the water loses its transparency to a great extent; and although, if seen in pitcher or tumbler, no change from its ordinary normal condition would be observed, yet in a deep reservoir you would see that there were minute particles of vegetable or animal growth which rendered the water turbid. It is not as clear as it would be in a covered reservoir.

Mr. Jones—I was wondering whether it was not a good deal like building cedar closets to keep moths out of clothing. My wife says a cedar closet is the best place for moths she ever saw.

Mr. Fuller—I would like to add that the Massachusetts Board of Health has gone into this matter very carefully and have made a great many examinations, and have come to the conclusion that covered reservoirs for ground water are much better than open ones.

Mr. Dunham—There is one point in which the practice of Mr. Fuller differed from my own. He provided a ventilator for his resevoir, and I did not, reasoning about it in this way;—that as the water rose and fell, on account of the use in the city, the air would be continually passing down through the roof and back again through the roof, probably the larger portion of it through the manholes; at any rate, it seemed to me that the water would not be so completely shut away from the air, even if no ventilator was provided, as the water in the ground is before it is taken to the reservoir at all.

Mr. Fuller—I would like to add one thing. I did not have in mind in putting in the ventilator at top of

the reservoir, the action of the air upon the water. It seemed to me that there ought to be something to allow the air to escape as the water is pumped in, and to allow it to re-enter as the water is drawn out. I thought it might add to the stability of the structure.

Mr. Gardner—I see Professor Leeds is here. Is he going to make a report?

The President If there are no further remarks on Mr. Dunham's paper, although it is not entirely in our regular order of business, we will now call up the report of the Committee on "Vegetable and Animal Growths affecting Water Supplies," of which Professor Leeds is chairman.

Professor Leeds I desire on the part of the Committee upon the taste and odors of potable waters, to report progress. During the year the committee has been engaged in obtaining such general knowledge as was available on this topic. I have examined with considerable care the literature on this subject, as far as has been practicable, and have obtained from water works engineers such items of information as they have been able to impart. During the year the committee has endeavored to advance from the consideration of such general information to that of a specific character. It has been able to come to the definite conclusion that the origin of these particular tastes and odors is to be found in specific organisms, animals or plants, which have developed in the waters at the time that these odors and tastes have been manifested.

The advance in the subject is of a precisely similar character to that in the domain of medicine. Formerly the origin of particular diseases in the class called zymotic diseases was attributed to general conditions of atmosphere, climate, etc. The great development in medical science during the past ten years has been due to the fact that the origin of these particular zymotic disorders has been traced to specific organisms; for example, that while humidity, and bad drainage, and unsanitary surroundings may aggravate the conditions in which phthisis, or diphtheria, typhoid fever or cholera, are propagated, yet in every case these diseases do not arise except there is a particular organism which has found its

way from a person previously afflicted with disease, through some medium and more especially through water in the cases of typhoid fever and cholera to the person subsequently afflicted.

So, also, with regard to disagreeable tastes and odors that affect waters. We now know that these are manifested when there are specific organisms, whether animals or plants, which are developed in the waters complained of. The committee has studied the subject with reference to the influence which the character of the water has upon the rate of development. It has found that some are more rapidly propagated in waters that are hard, containing excessive lime in solution, while others find a more congenial habitation in soft waters, which contain a large amount of dissolved vegetable matter. Others, again, as for example, sponges, develope best in running waters; the largest number of all develope most rapidly in stagnant waters. It is also found that some of these organisms develop a considerable amount of starch in the progress of their growth, others secrete oil, and others different kinds of organic material.

The object of learning the specific organism may not at first sight be evident. It may appear to be an over refinement of study to find out which particular algae is present in a certain water, or particular infusoria; but the labor and time spent in arriving at that definite opinion is more than repaid, and for this reason. No animal or plant develops rapidly except under conditions favorable for its growth. When a particular organism has been found, then the circumstances favorable to its growth become a matter of study and may be definitely ascertained. Another advantage gained from this course, that it is possible to bring about such conditions as would be unfavorable to the development, and it is in that direction that the water engineers will have occasion to work. The unfavorable conditions may be brought about by a reversal of the former conditions which have been of favorable character. If the water has been very soft, by hardening it by the introduction of lime or similar substance into it; if it is stagnant and has been favorable to the generation of large amounts of carbonic acid, and the dissipation of oxygen, reverse the conditions. Remove the carbonic acid gas and supply the oxygen.

As an illustration of what I mean, I may state this simple fact: some of the products that are formed are certainly in the nature of oils; in the nature of volatile oils. These oils would appear to be compounds, composed of a base in combination with an acid. This acid is volatile in its nature and disagreeable to the taste and smell. To show that such a body is produced, I will allude to the fact that frequently the simple introduction of a mineral acid, like carbonic acid, in such waters, may set free this volatile acid. I have known of cases where water that has not otherwise been complained of has become very offensive when charged with carbonic acid, which has brought about this decomposition. I have known persons using water in the manufacture of carbonic acid water to encounter that very difficulty.

With this explanation, it may be evident to you why it has not been desirable at the present time to do more than report progress; because to arrive at this information is a very tedious and laborious matter. I will simply, in conclusion, call your attention to the fact that labratory work upon these plants is very tedious and oftentimes discouraging, and that it is possible for every one of you to greatly facilitate these studies, and I trust you will so do by calling the attention of the members of the committee to the waters at the time they contain these growths, so that without loss of time the particular organism may be brought into the labratory, and all that is possible may be learned with regard to it, before the golden opportunity has passed.

My fellow member on the committee, Mr. Gardner, calls my attention to the fact that he has been successful in a case of preventive medicine, that was suggested to him by the labors of the committee. The reservoirs under his charge were persistently affected with a growth of an aquatic plant, the Potomogeton pusillus*, and he was successful in exterpating it; its mere removal did not cure the trouble. It was suggested to him that an application of lime in some form would kill the seeds of these growing plants. He removed the water from the reservoir, scrubbed them to a certain extent, and then applied a wash of chloride of lime, allowed the excess of

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NOTE.—This plant is a variety of what is commonly known as pond weed. The seed-bearing portions of this weed give off at times a very disagreeable odor.

chlorine to pass off, and then let on the water, and from that time on,—a year ago—there has been no manifestation whatever of a growth in his reservoir.

Mr. Decker—The reference to Col. Gardner's reservoir at New Orleans, and my own visit there last summer, recalls to my mind a remark by the gentleman which you will find recorded in the report of the sixth annual meeting. I will not attempt to quote his words exactly, but they were to the effect that in New Orleans, from which he came, they were pumping water from the Mississippi, and, of course, knew nothing of algae. I want to say that last summer I was there during August, and I saw more algae to the least quantity of water than anywere else under the sun. I do not think there is anywhere on this globe where they got as much algae in the same quantity of water as at New Orleans. I simply wish to show how a man changes his opinions, as he grows older.

Mr. Gardner.—I will simply say that this growth appeared in our reservoirs only after we ceased their practical use. As long as these reservoirs were in active use there was no grassy growth, no vegetable growth whatever; but after we had suspended their use for a time this growth developed.

Mr. Espy.—What species were they?

Mr. Corwin.—Were the walls smooth or rough before the water was allowed to enter?

Mr. Gardner.—They were fairly smooth. They were scrubbed down carefully and thoroughly, and a thin whitewash of chloride of lime was applied to both walls and bottom.

Mr. Decker.—I would repeat the question just asked, as to the name of the species.

Mr. Espy.—And at the same time whether there is a kind of algae that is beneficial to water.

Mr. Gardner.—I will ask Professor Leeds to answer that question.

PROFESSOR LEEDS.—The question is whether there are kinds of algae that are beneficial to the water. At the present time I do not think it could be answered affirmatively. Aquatic plants are certainly beneficial; purely aquatic plants secrete a large amount of oxygen, and they are beneficial. But I do not think it can be safely said that the lower order of plants, known as the algae, at the present time have been shown to be beneficial.

THE SECRETARY.—What is the technical name?

PROFESSOR LEEDS.—Vallace Natans.

THE PRESIDENT.—I think one question was, what was the name of the plant found in the New Orleans reservoir?

PROF. LEEDS.—I do not recall.

MR. DECKER.—The reason I ask the question is, that it is precisely a similar growth that I related last year at Philadelphia that we had at Winfield, Kansas, in the reservoir at that place. Long spores, hairy like particles, and filled with small snails, shell fish, and being fishy in smell.

MR. ESPY.—We are troubled with a kind of algae that I want to get some information about. We have been informed by those who have seen it that it is perfectly harmless, and is really beneficial. I have just for the moment forgotten the name of it, but my superintendent here has it, and I would like the Professor to see whether he knows anything in regard to that species.

MR. MONJEAU.—In my humble opinion, the algae, as we commonly call it when water in a reservoir is exposed to atmospheric warmth, is rarely beneficial. That is precisely why we are advised to have reservoirs on the surface light tight and air tight, and as cool as the ground source of the water you put in surface reservoirs. The growth of these vegetable germs that inhere in underground water supplies can only take place in atmospheric warmth, and if you expose water—as in an open reservoir that is not air tight and light tight and cool as the underground source—the development of these

germs is a benefit, but it is only a relative benefit; they should not be allowed to develop.

I believe I am the last gentleman who has evinced a desire to speak on this question, and I notice that no one has offered a resolution or a vote of thanks to Professor Leeds. I have to acknowledge to him that in the paper read by me I am under great obligations to him for certain suggestions, which, however, proved fruitless of the desired results, but they have been a great satisfaction. It is a good thing to learn that we cannot do certain things. I desire to suggest that the knowledge I have derived from the few words of Professor Leeds as chairman of that committee is worth all my expenses in coming to and attending this convention. I desire to call your attention, gentlemen, to the fact that it requires an enormous amount of labor to acquire the knowledge necessary to give utterance to the facts he has stated. I trust you will all be as grateful as I am; they have been a decided benefit to me; it is just the knowledge that we need here, and I trust the stenographer has these things for us. I do intend that it should go on record that we have the gratitude and the good sound common sense to thank a man who can do so much work for us as a member of this Association.

The President.—A motion is made and seconded that the thanks of the Association be tendered to Professor Leeds for his able report. Carried.

Mr. Linneen.—It seems to me that the work of this committee is hardly completed. There is still work before the committee, and I think a motion for its continuance would be in order. I would like to state that I understand that there is a similar committee appointed by the American Society of Civil Engineers, and that they would like to co-operate with our committee. I had hoped that they would be here this afternoon. In this way something might be accomplished. I think our committee should have power to consult with them, if arrangements can be made. I therefore move that this committee be perpetuated and continued in existence until the next annual meeting of this Association; and that whatever they can do as a committee, or individually, with other committees of similar organizations,

that they be empowered to act in their discretion, and that they give this association the benefit of their knowledge at the next meeting.

MR. MONJEAU.—Will my friend allow me to make a suggestion?

MR. LINNEEN.—Yes, sir.

MR. MONJEAU.—Professor Leeds has reported progress only. I believe it is parliamentary usage, when progress is reported, to understand that the committee continues in force with all its powers. It is not in any way limited. If our friend would kindly make his motion contain only the new point that they be requested and empowered to act with other committees, it will be all that is necessary; if you say the committee of the American Society of Civil Engineers, very good. I would suggest further that you will embody in your motion, if you will be good enough, that they confer with our committee of the American Health Association.

MR. LINNEEN.—I have no objection to these suggestions, and embody them in my resolution.

Mr. Linneen's motion put was and carried.

MR. GARDNER.—I would like to ask if any gentleman knows whether Professor LeConte of California is alive or dead?

THE PRESIDENT.—He is alive. He has lost, he said, two members of his family. The J. LeConte, who died, was a brother. He has also lost an uncle.

MR. DECKER.—I know that our committeeman was alive three or four weeks ago.

THE PRESIDENT—The next order of business will be the question box.

MR. DONAHUE—I would like to ask if this Association has taken any action on the suggestion offered this morning by Mr. Monjeau on the preparation of a memorial to Congress relative to the investigation of domestic water supplies and of the pollution of our streams by sewage.

I do not think the Association fully understands the importance of this matter. I think it would be well to express the sense of this Association either by resolution now or by the appointment of a Committee to investigate into the matter. It is a very important matter, involving the question of life or death to thousands, that the domestic water supplies be protected. We have our State organizations for analyzing milk, and we have the Government system of testing and gauging the whiskey that people drink. Why should the Government not see that people drink good water. I do not mean by that to investigate the water supplies, and to condemn or recommend the public water supplies, but simply to protect the streams from which we get the water. As the growth of different towns necessarily makes the surface wells and cisterns more or less impure and contaminated by the filth that accumulates around these places, or near by in the shape of privies, vaults, etc., I think that some action should be taken whereby these domestic wells should be examined; not with a view of condemning them—with the consequent effect of helping a water company—but for the protection of health and life. If they find good wells, recommend them; if they find impure ones, condemn them. I think the different American streams, from which the different companies get their supplies, ought all to be protected. There must be something done to keep our sewage out of our rivers that pollute our streams. It is looking a long way ahead, perhaps, but the time is coming when the streams will be polluted to such an extent that it will be almost impossible to provide pure water, by filtration or any other means. I would like to suggest that the Association consider something of the kind.

Mr. Gardner—I heartily endorse what Col. Donahue has said; and whatever may be said about the merits or demerits of the paternal Government, this is a matter that ought to be attended to at once by our State Legislatures and our National Congress. New Orleans, away down yonder a peninsular—a long way out of the line of traffic—has taken a step in advance, in this direction, in closing up all wells, and not permitting them to be used. The State Board of Health has caused every well to be

closed. Well water cannot be used there to-day for any purpose whatever, for man or beast.

THE PRESIDENT—I tried to say in my opening address that there were three alternatives for us in this matter. We must either turn our attention to improved methods of sewage and educate the people to it, or we must have restrictive legislation compelling the people to keep the waters pure, or we must purify the waters. I think the first proposition is the best. The water should be kept pure.

MR. LINNEEN—I quite agree with the President and the two previous speakers on this important subject. It is a subject which is staring the people of this country in the face, and one that requires the closest consideration from the educated minds of the country as to the best manner in which to prevent the pollution of streams and public water supplies. Local State laws will not reach this question. It is to be reached only through Legislation at Washington. If it is ever reached, it will only be through national laws, because the State of Pennsylvania cannot prevent the State of New York from polluting streams that flow through that commonwealth; neither can the State of Iowa, from which Col. Donahue hails, prevent the city of Chicago from building a canal to dump her sewage into the Mississippi river, and they are going to do it, and when it gets down to New Orleans they will feel it.

Without elaborating on this subject further, I would move you, Mr. Chairman, that the President of this Association appoint a committee of three to present a memorial to Congress, asking Congress to take some steps, or do something, towards the prevention of the pollution of streams which are used for public water supplies.

MR. MONJEAU—Will you permit the reading of the petition which I have already prepared to the President and Congress of the United States. I will read it, and we will see if it suits the ideas of the maker of the motion.

MR. LINNEEN—I will withdraw my motion that I made, having been in ignorance of what brother Monjeau

has read. I move, instead, that this organization adopt the preamble and resolution of Mr. Monjeau, and give it the countenance of the Association in its presentation to the Congress of the United States of America.

The President—As I understand the motion, it is that this Association shall adopt some form of resolution, which will be presented to Congress as coming from the Association, without the intervention of any committee.

Mr. Linneen—I move that this Association, in convention assembled, endorse and approve, by their vote, the resolution whi h has been read by Mr. Monjeau. That this resolution be adopted and sent officially from this Association to Congress.

Mr. Jones—I am in favor of the motion to send it on, but it will do no good. The Congress of the United States knows as well as we do, that the rivers of the country are the public sewers of the country; and they cannnot prevent it, and the waters must be purified. The rivers will still be used as the sewers of the country.

Mr. Benzenberg—Mr. President, I am heartily in favor of the movement, and believe it should emanate from this national body. I am fearful, however, that unless the matter is presented with considerable care, with even more than that contained in the resolution, it may not receive the attention at the hands of Congress that the question certainly deserves. We do not want to be hasty in forwarding a set of resolutions that will not within themselves contain the evidence of the statement. I believe it would be wiser if this matter was referred to a special committee with authority to properly draft a memorial, and have the same sent to Congress by authority of the Association. I believe a question of that kind, coming from an Association like this, and going to the National Legislature, merits a little more attention and study before its passage.

I believe it would be better if we deferred, or rather referred, the language of the resolution to a special committee, so that it may be carefully drawn, containing within itself statements enough to show that it represents what it states, and there is no lack of information

on that subject to be had throughout the country; and in this way it will be more likely to receive the attention of the body to whom it is addressed. I do not wish to make a motion, but I merely suggest this.

MR. GARDNER.—I second the foregoing as a motion; and further, that the committee be the incoming President and Secretary, with power to act.

MR. BENZENBERG.—I think that the committee ought to be selected from the body of this Association, with reference to the ability of the gentlemen composing it to properly prepare the document. We want the strongest man to work on this question, which is of national importance. I do not make these remarks at all in opposition to what Mr. Monjeau has offered; but I think it should be made still stronger, even, than the form he has presented, in order that it should carry sufficient weight. I am fearful that it is not strong enough.

MR. LINNEEN.—I am glad to have been instrumental in drawing out these suggestions from the members. We have just voted to continue and perpetuate the committee headed by Professor Leeds, for the coming year. Now I want to offer an amendment to my own resolusion, if it is in order, namely, that this committee that we have instructed to continue, collect and gather together as much available information on the pollution of water supplies in this country as they can within this present year and present them to our next meeting, and at that time we embody the resolution of my friend Monjeau in a memorial to Congress for legislation which shall as far as possible prevent the pollution of streams.

I agree with Major Jones that no doubt the Congress of this country recognizes the fact that our great public water ways are also our public sewers; but that can be prevented. Congress can prevent these streams being polluted or made public sewers. There is another point bearing on the modern way of disposing of sewage in cities. If cities are willing to incur the expense a better way is open—burn it up. I say that unless this Association takes some cognizance of this fact and through our efforts inaugurates some legislation that will be effective in its way, this pollution will keep on and the

health of the public will be endangered more than it is now. As cities increase in population the pollution will become greater and greater every year. I think that the present is a good time for this Association to do something to stop it. My ideas may be crude, but I trust the matter will result in something being done with this object in view.

Mr. Monjeau.—Mr. Chairman, I am truly grateful that so many of you gentlemen sympathize or feel with me in this matter; but when I consider that every five minutes a human life is extinguished for the want of action in this direction, I do feel as though you might possibly devise some way of appointing a committee or adding to your present committee—adding your President and Secretary and a member or two besides, and attending to this matter at once, embodying Mr. Benzenberg's ideas. I ask every one of you who has opened his arms at the altars of love for some God-given form, whose dear life was being extinguished the next five minutes, would you delay, would you delay for a second to take action to bring before the Congress of the nation—the natural arm of protection for the general public—this matter in its strongest form? I have lost my only son, who grew to maturity or to reasoning power, in this way; and I have learned since I have come here that others of you go with these arms empty and your homes blasted, because of the inability of our most learned and able men to direct the public sentiment in the proper direction in this regard. Now I beg of you, in the name of the love we bear our country, the love of our homes, the love of our children, our wives and daughters, let us see to it now. Let us do something. We have waited and faltered long enough. Let us do something now, if you please. (Applause.)

Mr. Davis.—On behalf of the Indianapolis Water Company I would request that there be no delay in this matter. We are now engaged in a very expensive suit with the American Straw Board Works, and they say to us that the city of Indianapolis has got to take care of itself; that we manufacturers have a right to pollute the streams; we have a right to make them sewers. They have even gone so far in law suits as to offer proof that

they benefited the streams ; that the stuff they put into the stream is not harmful but beneficial. They have tried cases before the county courts and have been successful. We are before the United States Court and do not expect any such result. We expect to be successful in our suit. However, of course, that lies with the court; but we hope to win. We ask that this matter be not delayed, but that action on it be taken promptly.

Mr. Linnen.—I want to simplify this matter before it is put to a vote. I withdraw, with your permission, Mr. President, all my previous motions on this subject. I offer, instead, this motion : That this whole matter be referred to the committee that we have asked to continue another year, and that the incoming President and Secretary of this Association, with Mr. Monjeau, be added to the committee, with power to act in this matter at the earliest possible time.

Mr. Gilbert.—In order that there may be no mistake about this motion, I wish to say that my understanding is that Mr. Linneen offers this last motion as a substitute for the whole matter ; to take the place of his first motion and the one or two amendments that have been offered.

Mr. Linneen.—That is correct.

The President then put the motion, which was carried.

The President.—The next business before the convention is the report of the Committee, on the World's Columbian Exposition, which report Mr. Benzenberg will make.

Mr. Benzenberg.—Mr. President—At your suggestion I submit a matter that has been considered by the Executive Committee, and submit it, without recommendation, to the Association for action. The World's Columbian Exposition Board of Directors, for the purpose of facilitating conventions of the various national and inter-national organizations during the time of the World's Fair, has organized what is called the World's Congress Auxiliary, and put the same under a separate management, but still under the control and direction of

the World's Columbian Exposition Board of Directors. Mr. C. C. Bonney is President of this organization. Preparations have been made to further the objects of this organization and space will be provided for all national organizations that intend to hold congresses in Chicago during the time of the Fair for the purpose of discussing matters competent to the character of their Associations. Amongst the departments or congresses that of "Engineering" has been arranged for. A general or executive committee of the Engineering Congress has been appointed, of which Mr. E. L. Corthell is chairman. The object of this particular department is to facilitate the convention of engineers and engineering societies for the consideration of live questions in the various divisions of this department in connection with the World's Columbian Exposition to be held next year in Chicago.

All the various engineering societies and other technical associations throughout the country have joined in this movement; and among the departments that have been assigned and for which arrangements have been made, are these: Civil Engineering; Mechanical Engineering; Mining Engineering; Metallurgical Engineering; Electrical Engineering; Military Engineering; and Marine and Naval Engineering; and embracing for especial attention as subjects of public interest, the construction of Roads, Railways, Canals, Tunnels and Water works; the making of River and Harbor improvements; Systems of Sewerage and Drainage; the building of Bridges and other Structures. The subject of Water works has not been assigned a distinct place, as no other organization representing that particular feature of engineering has made application. This Association has not done so, neither has the New England Association, as I understand. Thinking that it was not possible for the American Water Works Association to take an independent stand, like that of the electrical engineering department, which could be independent on account of their strength and power, and that it might be well for the American Water Works Association to connect itself with the department of engineering, now in charge of the executive committee of which Mr. E. L. Corthell is chairman, I wrote a letter to that committee, and in reply received the following :

OFFICE OF
GENERAL COMMITTEE OF ENGINEERING SOCIETIES,
COLUMBIAN EXPOSITION,
CHICAGO, May 6, 1892.

Mr. George Benzenberg, City Engineer, Milwaukee, Wis.

DEAR SIR :—Reply to your letter of January 4th, 1892, could not be made until after a meeting of the General Committee on Engineering Congress and Headquarters of the Columbian Exposition. I am now able to inform you that at a meeting of said General Committee on the 4th instant it was decided that the American Water Works Association should be considered an engineering organization and as such would be eligible to become a part of said Congress and also secure the advantages of Headquarters upon application to the Executive Committee, and by making subscription to the fund now being raised for the support of said headquarters. Yours truly,

D. J. WHITTMORE, Vice-Chairman of the Ex. Com.

The Committee of Engineering Societies has since decided upon a plan to hold conventions, not only of home talent, but of all members of the various European engineering societies, some of which have consented, upon invitation, to be represented by delegations; and I understand that nine-tenths of all the engineering associations and organizations throughout Europe have agreed to participate in the various congresses.

Immediately after receiving the above letter, I wrote another, to which I received the following reply :

CHICAGO, May 10, 1892.

G. H. Benzenberg, Esq., Milwaukee, Wis.

DEAR SIR :—Mr. Whitmoyer has forwarded to me your inquiry of the 7th, concerning proposed headquarters for the Associated Engineering Societies.

It is proposed to maintain during the Exposition of 1893 some headquarters for the Associated Engineering Societies within the business limits of Chicago, and in close proximity to the hotels. These will probably consist of a private house or flat, or a suite of rooms, in which there is to be an attending Secretary, and staff of assistants, in order to receive visiting engineers, furnish them such information as they may require, and bring about meetings with local engineers, or such other citizens of the city as the visitors may desire to meet. In addition to this, it is also proposed to maintain a small staff within the Exposition itself, which as you know is seven miles distant from the business portion of the city, in order to pilot visitors through the Exposition, and to point out to them the location of such exhibits as they may desire to see.

In addition to this, again, there is to be an International Engineering Congress, consisting of several Divisions, the organization of which has been placed in the hands of the corresponding societies.

The expense of this has been estimated at $15,000, but a number of

applications having been received from other Engineering Organizations to join the sixteen societies with whom the scheme originated, it is possible that the scope and expense of the Association shall be increased. In view of this it was voted at the meeting of the General Committee of the Associated Engineering Societies held in this city on the 14th of May, that additional Engineering organizations might be admitted to the Association, if approved of by the Executive Committee, but that in such cases the basis of their admission should be at the rate of $5.00 per member for their present membership, instead of $2.00 per member, which formed the basis for the original apportionment of the quotas.

It should be expected in every case that application should be made to the Executive Committee, E. L. Corthell, Chairman, The Temple, LaSalle St.. Chicago, by the Society desiring to become a member of the Association.

We send you herewith such printed matter, as has heretofore been issued, with reference to the proposed headquarters and Engineering Congress. Yours Respectfully,

O. CHANUTE, President, General Committee.

The engineering congresses are to be held in rooms provided in the Art Memorial Building, to be erected on the Lake front. It seems to me that this is a time when this Association by identifying itself in some form with the Columbian Exposition, will advance in recognition and bring itself more prominently to the notice of people interested in scientific pursuits. I do not think it would be well for the American Water Works Association to be, possibly, the only body of a national character, and of such prominence as this organization, that had not become identified in some way, either in exhibition or by participation in the Congresses, with the other societies at the time of the Exposition.

I believe it would be wise for us at this time to take some action with a view of identifying ourselves with this movement. I do not present this with the idea that the next convention shall be held in Chicago, but that at some proper time during the summer, when all the other engineering societies are in session, one department after another, and are having their lectures and discussions on various subjects, and which will be open to the public, that we during that period could select some time and provide for a similar congress. I bring this matter up for the purpose of having the Association take some action on it.

MR. GARDNER.—I move that the discussion of the matter be postponed until after we select our next place for holding our annual meeting.

Mr. Linneen.—I move as an amendment to the motion of Mr. Gardner that Mr. Benzenberg, who has already given us the information that we have on this important subject, be instructed by this Association to devise some scheme, whereby we can carry out some of the suggestions contained in his remarks, and present his conclusions at the meeting to-morrow afternoon. By that time we will have made a selection of our next place of meeting. Personally I am opposed to becoming the fifth wheel of any other organization in this Columbian Exposition. The inception, planning and extension of water works in this country for the last fifteen or sixteen years, during which time I have been connected with the business, has offered to the Engineering profession of this country a more prolific field for the application of the technical skill which they possess than any other branch of industry within my knowledge. I say that in the planning of water works the engineering profession of this country has had a broader field to labor in than almost any other. We have listened with interest and I trust with profit to the learned statements made at our morning session by the Chief Engineer of the improvements, now nearing completion, of the water works of this Metropolitan City of New York. The Croton aqueduct, the several impounding reservoirs, the great masonry structures and tunnels, and the engineering work connected with this stupendous undertaking, must forever remain and be admired as monuments of engineering skill of which a parallel can scarcely be found in either railroad or mining engineering. The original planning, extension and improvements of the water works of our great and growing cities must in the future as in the past, require and command the best engineering talent obtainable. Personally I am, I think we all are, proud of this organization and the engineering talents of its members, I repeat that I am opposed to visiting the Columbian Exposition next year in the shadow of any of our sister societies. We are strong enough, numerous enough, and possess talent enough to make ourselves known and recognized as a separate organization.

Mr. Gardner.—Mr. Linneen's motion virtually cov-

ers mine; and I therefore withdraw my motion and second his.

THE PRESIDENT.—Will Mr. Linneen please repeat his motion.

MR. LINNEEN.—My motion is that Mr. Benzenberg be requested to formulate a scheme in writing to present to this Association at its meeting to-morrow afternoon, with a view of carrying out his ideas.

THE PRESIDENT.—We have no further meeting. This is our final meeting.

MR. BENZENBERG—I believe there will be a meeting for final adjournment. I hope, however, that no such motion will prevail, because I am not prepared to devise any scheme which would meet the views of this Association. I do not believe, with due deference to Mr. Linneen's opinion, that we are strong enough to support headquarters of our own. I do not think there is anything derogatory in combining ourselves with other engineering societies, provided they are all combined together to represent special industry. The expense of maintaining headquarters of our own would be very much, indeed; and I doubt whether we would be able to find the wherewith to maintain such headquarters.

THE PRESIDENT—The motion before the house is that Mr Benzenberg be requested to formulate a plan by which we can avail ourselves of these privileges, and report at our adjourned meeting. Carried.

THE PRESIDENT—Our next order of business is the report of the Committee on Nominations.

MR. GARDNER—Your Committee instructed me to report as follows:

For President—G. H. Benzenberg, Milwaukee, Wis.
For Vice Presidents—James P. Donahue, Davenport, Ia.
—R. P. C. Coggeshall, New Bedford, Mass.
—R. M. Clayton, Atlanta, Ga.
—S. E. Babcock, Little Falls, N. Y.
—W. H. Watts, El Paso, Texas.

For Secretary and Treasurer—Peter Milne, New York City.

Mr. Espy moved that the report be received, and that the Secretary cast the ballot of the members of the Association for the gentlemen named. Carried.

The Secretary—I hereby cast the ballot in accordance with the vote of this Association just passed.

The President—I will appoint Mr. Gardner and Mr. Jones a Committee to escort the newly elected President to the chair.

Mr. Benzenberg—Mr. President and gentlemen of the American Water Works Association—I certainly thank you most heartily for this expression of your confidence in me, in placing me at the head of your organization. I trust that nothing in any of my actions at any time will in any way check the progress of the Association; but that I may be able in some way to enlarge and advance its usefullness. I hope, if I should make a mistake in any manner, you will bear with me; for it will be an error of the mind and not of the heart. I mean to do what I can in forwarding the objects of this association. I thank you heartily for your kindness. (Applause.)

Mr. Linneen—Gentlemen of this Association: I want to make a suggestion. Thus far this organization has been blessed with a good line of officers, from the time of its inception twelve years ago, up to the present day. The action of the Committee this afternoon is in line with the action of former committees in calling to the executive positions in the gift of this Association tried, true and good men. But it has occured to me, and it has been whispered around in various quarters, that we should deviate a trifle from the modus operandi that governed heretofore in the election of officers for this Association. I but voice the expressions of a great many members of the Association that would like to have some voice in the selection of officers. This may be a disagreeable subject to many of my hearers, but we are a democratic organization. To the tax payers belong the right to vote. They have a right to select their officers. Now,

with due deference to the incoming officers, I want to offer a resolution here, if it is not unconstitutional, that hereafter a committee be selected by the members in convention assembled to nominate officers, and that committee select two tickets for this organization to vote upon, instead of the present way. I would like to have that question discussed a little by this Association; or if you think it best, continue the old way. These are the suggestions that have been made to me, and I have been asked to present them to the Association.

Mr. Jones—The manner in which this thing has been done formerly seems to have met with universal satisfaction; and as this is a purely democratic convention, I move we continue the same old way, I think it is the best way to do.

Mr. Espy—What is the old way?

The President—The appointment by the chair, by and with the advice of the Executive Committee, of a committee to make nominations to present them to the Association, to be acted upon by the Association.

Mr. Milne—Is not this motion out of order? What is the use of a motion where we are not changing anything at all?

Mr. Linneen—I move that hereafter the nominating committee of this Association be named by the members of the Association.

The President—If any motion is in order, the other motion is pending.

Mr. Johns—Is not the other other motion out of order?

Mr. Milne—What is the question now under discussion?

The President—That the old form of appointing the nominating committee be continued.

Mr. Linneen—I am in favor of allowing the members of this Association to appoint the nominating committee in open convention from among their own

members, and give all a voice in the selection of their officers instead of going in and voting for a ticket prepared by some one else.

THE PRESIDENT—The chair rules the motion of Major Jones in order.

MR. MILNE—I cannot see the logic of the motion of Major Jones. That is the procedure now adopted by this Association. If there are any changes to be made in the Constitution, now is the time to propose them. Mr. Linneen simply makes a suggestion. He is feeling the pulse of the Association; that is about the size of it. He knows, and we all know, that there are a number of our members who want this custom changed. If there is any man on the floor of the convention who has the success of the Association at heart, I think I have it with all of you. If I knew there was one man in this Association that believed that either Mr. Benzenberg or myself were incompetent, I would retire. If I felt that any man had an objection to me as Secretay of your Associations, I would retire That is my disposition.

Gentlemen, the power of this Association is felt throughout the land; and to continue to have it so, we must place shoulder to shoulder, and elbow to elbow. There must be one united purpose to carry out the objects of this Association, to ensure their full development. Why should there be any difference of opinion upon this subject? If your nominating committee is incompetent, if your president is incompetent, it is easy to determine the matter in convention. If the committee submits a ticket that does not meet the thought and purpose of the Association, each man has the right to get up and dissent. That is democracy. It is Americanism; typical Americanism. Every man on the floor of this convention has the right to express his opinion, his thoughts and purposes.

As to a committee, who knows better the conservative power of this convention than a committee? Do men who now come in, and they that have only been members for one, two or three years, do they know as well—perhaps they do—who will make the best officers for this Association? They cannot in the nature of things be as well fitted for this as our older members.

They have not had the experience. We ask them to co-operate with us. That is the reason why the committee is appointed, so that the most suitable selection may be made. It is not that this particular man, or that particular man should be nominated, it is not that this, that or the other man should fill a certain position; the idea is collective; we take them all in. We want to make the best choice we can and have all sections represented. It is not to advance individual interest; it is the collective interest—that is the power of the Association. Why, if any gentleman comes to me, and says "I dissent—I do not like this man." I say to him, "get up and express yourself in a manly American fashion." If the nominating committee cannot properly represent the progress of the Association, do away with it. I am willing to do all I can to crystalize and strengthen the objects and purposes of the Association. (Applause.)

Mr. Decker—To settle this matter and cut off debate, I would state, in the first place, that there has been a Committee appointed to revise the Constitution. As this is a constitutional question, and it should be provided for in the Constitution. I move you, sir, that the whole matter be referred to the Committee on the Revision of the Constitution, and that they consider the matter and embody it in their report.

Mr. Jones—I simply wanted to say that the object of my motion was to prevent in this Association a scramble for office.

Mr. Linneen—I think Mr. Milne does not fully understand the suggestion made by me. It goes without saying that the action of the nominating committee at this meeting is wholly satisfactory, because the Association has unanimously instructed the Secretary to cast the vote of the members for the officers named. It is hardly necessary to say that the Committee to-day could not have made a better selection. It is my choice all the way through. The question is this—whether the Association in convention assembled shall nominate its officers, or whether it shall be left to a nominating committee appointed by the President. My suggestion was that this body appoint the nominating committee; that

the members of this Association, collectively, shall appoint the nominating committee. I apprehend that if this is done we will have just as good officers in the future as in the past; and it will give better satisfaction to the members at large. They will have a voice in the selection of our officers, and they will feel that they will have a voice. It is no digression from established rules of other bodies; it is no reflection upon the President of this Association; it is no reflection upon the present or past officers of this Association, that the nominations should be made in this way. It is only a suggestion from me, and I would not have offered it, if I had not heard it noised around at this and other meetings that it would be preferred.

MR. JONES—Mr. Linneen is mistaken as to who compose the nominating committee. That committee is not appointed by the President. It consists of the President, Vice-Presidents, the Acting Past President, the Finance Committee, and the Secretary and Treasurer.

MR. LINNEEN—I object to them making any more nominations.

MR. WANNER—The motion of Mr. Decker is before the house, and will settle the whole business.

The motion of Mr. Decker was then put and carried.

THE PRESIDENT—The selection of a place for the next meeting is the next business in order.

MR. BENZENBERG—In behalf of the city of Milwaukee I extend a cordial invitation to the American Water Works Association to hold its next annual meeting in our city. We have not as many members in our Association from Milwaukee as we have from other places where the Association has met in past years. There are but two of us from the city of Milwaukee; but we will do all we can to make it comfortable and pleasant and homelike to you. We will show you what we have, and we will entertain you as best we can. I believe that it will be the best place for you to meet in next year, because I do not think you will find in the city of Chicago the conveniences and the comforts that the Association has been

accumtomed to enjoy, wherever it has met. The hotels of Chicago will be crowded, and it is a question whether you will at any one hotel find the room and space to hold a convention. Milwaukee is but two and one-half hours ride from Chicago, and next summer will be but two hours; so that it will not be far out of your way, as every one will want to visit the Exposition. We have a city that will show up, I think, in natural beauty and cleanliness and improvement with any other city on the continent. We have not the number of sight-seeing places that Chicago has, or that New York or Philadelphia can show you. We are not an historic city; but we have got places that you may find pleasant enjoyment in, sufficient perhaps to pay you for your visit to Milwaukee if you come. I extend you a hearty welcome to hold your next annual meeting at Milwaukee.

Mr. Linneen—I move that the invitation extended by the incoming President of this Association to hold our next annual meeting at the city of Milwaukee be accepted.

The President put the motion, which was unanimously carried.

Mr. Wanner—Who will fix the time of the meeting?

The President—It is fixed by the Constitution, subject to change by the Executive Committee.

Mr. Wanner—The time might be important in this matter, so far as the Exposition is concerned. The time may be an important factor. I do not know what would be the best time. I would like to hear from some of the other members.

Mr. Benzenberg—That is one of the points I wanted to bring up, so that the judgment of the Executive Committee may be guided by the wishes of the Association. No doubt May will be a rather early month to visit the Exposition, as a great deal will be in an unfinished state and the exhibits incomplete. It is also not the best time to visit a city so far north as Milwaukee. We are not advanced as you are here in May. I think the middle of June would please you all the best, as not being the

warmest month of the season, yet it would be sufficiently advanced to show up Milwaukee better, and is also a month well adapted for a visit to the Exposition. These are my own views, but I would like to hear from the members.

MR. WANNER—It strikes me very favorably.

THE PRESIDENT—I will read Article VIII.

MR. LINNEEN—I wish to offer a suggestion—that the middle of June, in my opinion, would be pretty early for the meeting to be held next year, for certain it is that they cannot get the Exposition in complete running order as early as the middle of June. The Exposition does not open until May, and you all can well imagine it will take from thirty to fifty days before everything is running in proper shape, and inasmuch as the New England Association has its meeting in June, I would suggest that the Committee designate the latter part of June or the first part of July.

There is another reason; May and the first part of June are not very good months in which to drink beer, and Milwaukee is known the world over for the quality of beer. This is one of the points that brother Benzenberg did not touch upon; but I thought I would give the city a boom. I am in favor of the latter part of June or the early part of July as a good time.

MR. WAGNER—It may be very well, perhaps, for my friend to speak about the latter part of June or July, but it should be remembered that there are a great many members that have not their time at their command to go at any time. We who have to go into our work for our extensions and betterments during the year would have a hard time getting away in July. A man who has nothing to look after of this kind can do it easily. I think there a number of men with whom it is likely to be hard to get away at that time. Certainly it would be for me.

MR. MONJEAU—Judging from our experience at Philadelphia, in 1876, at Vienna, at London, and at Paris, we may safely assume that the Exposition will not be in full running condition before the middle of

July; and if we want to see the Exposition in its best shape, we had better make our meeting pretty late.

Mr. Milne—I should prefer August to any other month; certainly not June.

Mr. Linneen—I want to suggest to this Committee on National Legislation one thing—that the Sanitary Commission, the National Board of Health, for the last four years has been tied up for the want of funds. There has not been any appropriation for the expenses of this Board, and I want to remind this Committee that in the memorial that they present to Congress they respectfully ask that body to provide funds for the use of that Board.

Mr. Espy—I move we adjourn.

The President—The meeting will stand adjourned until Saturday. We will hold our adjourned meeting on the boat, and we hope that all the gentlemen will be present.

Saturday, May 21st.

Pursuant to adjournment, meeting was called to order by President Diven at 3 o'clock p. m.

REPORT OF EXECUTIVE COMMITTEE.

To the Members of the American Water Works Association:

Gentlemen—Your Executive Committee would respectfully recommend that the matter of participation in the "World's Congress Auxiliary" be referred to the President and Secretary elect, vesting in them full power to act.

Second—That the time for holding the 13th annual convention be fixed for the week commencing September 4th, 1893.

J. M. Diven, President for the Executive Committee.
J. H. Decker, Secretary.

On motion the report was unanimously adopted.

Mr. J. F. Sawyer offered the following:

Resolved, That the thanks of this Association be tendered to the members of the Local Committee for the able manner in which they have

performed their duties, and for the most enjoyable entertainment that has been accorded during this convention.

Adopted unanimously.

Mr. L. H. Gardner—I offer the following resolutions:

Resolved, That this Association unanimously extend to the National Meter Company its sincere thanks for and most hearty appreciation of the steamboat excursion with its pleasurable accompaniaments so generously tendered by them.

Resolved, That the thanks of the members be tendered Mr. George W. Bramwell for the many kindnesses and care extended to our wives and daughters.

Both resolutions were adopted.

The President elect, Mr. G. H. Benzenberg, and Secretary, Peter Milne, were escorted to their respective positions.

On motion of Mr. Linneen, the thanks of the Association were voted to the retiring officers.

Adjourned.

J. H. Decker, Secretary.

THE EXHIBITS.

The accommodations provided for exhibitors was better than hitherto obtained at our Conventions, and though well adapted for the purpose, it was to our regret that part of the exhibit was obliged to be located in other portions of the building because of want of room in the main exhibition hall.

The following named manufacturers were represented:

Hersey M'f'g Co., Water Meters ..... Boston, Mass.
The H. Mueller M'f'g Co., Tapping Machine ..... Decatur, Ill.
Pressure Regulator, Albert D. Cypher ..... Peekskill, N. Y.
The Thomson Meter Co., Water Meters ..... Brooklyn, N. Y.
The Rose Valve Co., Pressure Regulator ..... Troy, N. Y.
H. R. Worthington, Water Meters and Pumping Machines, Drawings and Diagrams ..... New York City
Thomas Watkins, Pipe Jointer ..... Johnstown, Pa.
Anthony P. Smith, Machine for tapping Water Mains for branch connections ..... Newark, N. J.
Holly M'f'g Co., Fire Hydrants, Gates and Drawing and Diagrams of Pumping Machines ..... Lockport, N. Y.
National Meter Co., Water Meters and Gas Engines ..... New York City
Jarvis B. Edson, Pressure Recording Guages ..... New York City
Dean Steam Pump Co ..... Holyoke, Mass.
Deutsch, W. M ..... New York Filter Co
Eddy Valve M'f'g Co ..... Waterford, N. Y.
Hinds A. H. Jr. Tuerk Hydraulic Power Co ..... Chicago, Ill.
Illinois Malleabe Iron Co., Water Works supplies ..... Chicago, Ill.
Kellogg, E. H. & Co., Machine Oils, etc ..... New York City
Utica Pipe Foundry ..... Utica, N. Y
Snow Steam Pump Co ..... New York City
Union Water Meter Co., Water Meters ..... Worcester, Mass.
Michigan Brass and Iron Works, Hydrants and Gates ..... Detroit, Mich.
The Brass and Iron Works Co., Tapping Machines and Brass Goods ..... Fostoria, Ohio
Walter S. Payne, Brass Goods and Tapping Machines ..... Fostoria, Ohio
R. D. Wood & Co., Gates and Fire Hydrants ..... Philadelphia, Pa.
Chapman Valve Co., Gates and Fire Hydrants ..... Indian Orchard, Mass.
Rensselaer M'f'g Co., Gates and Fire Hydrants ..... Troy, N. Y.
Fisher Governor Co ..... Marshalltown, Ia.
National Tube Works Co., Wrought Iron Pipe and Converse Joint ..... McKeesport, Pa.
Fairbanks & Co., Brass Valves and Gates ..... New York City
Bristol M'f'g Co., Pressure Guages ..... Hoboken, N. J.
Rose & Hills Co., Water Works and Plumbers Supplies ..... Cleveland, O.
Walworth M'f'g Co., Water Works Supplies ..... Boston, Mass.
Union Hydraulic Works ..... Philadelphia, Pa.
Dr. Leslie West, Sterilizer Apparatus ..... Bound Brook, N. J.
W. H. De Washington, Driven Well Tube Point Machinery ..... New York, N. Y.
Gordon Steam Pump Co ..... Hamilton, Ohio
Stardard Thermometer Co ..... Peabody, Mass.
Ludlow Valve Co ..... Troy, N. Y.

THE PRESS.

The Technical and Local Press were represented as follows:

TECHINAL PRESS.

Engineering News, New York City..... M. N. Baker, Asso. Editor.
Fire & Water, New York City..... F. W. Sheppard, Asso. Editor.
B. J. Fredericks, Manager.
Western Fireman, Chicago..... I. E. Smith, Jr. Editor.
Water and Gas Review, New York City..... T. C. Toal, Editor.

LOCAL PRESS.

New York Daily News.....
New York Tribune.....
New York World.....
New York Mail and Express.....
New York Herald.....

The Social Feature

New York city is nothing if not hospitable with respect to entertainment of visiting society organizations. The kindred organizations of the city evinced their courtesy by extending invitations to the members of the Association and their guests to avail themselves of the use of their club rooms. It was a matter of regret that the members for want of time could not respond to every invitation.

The Local Committee made ample provisions for the entertainment of the Associations and its guests.

The Reception.

The Reception in the large dining hall of the hotel on Tuesday evening, given to the members of the Association and ladies by the city officers and prominent citizens was a noteworthy incident being entirely free from formality, and was the occasion for full enjoyment of delightful music, good cheer and pleasant interchange of sentiment, inspired by the presence of a large assemblage of ladies.

On Monday the ladies of the Local Committee, under the managment of Mr. George W. Bramwell, a member of the Local Committee, escorted the visiting ladies in carriages to various places of interest.

Theater Party.

The evening was devoted to the enjoyment of a visit to the Star Theater and was fully attended by over 300 of the Members of the Association the ladies and guests of the Convention.

Drive Through Central Park.

Tuesday afternoon was enjoyed by the ladies and members of the Association by a carriage drive through Central Park.

All Day Excursion, Accompanied by the Ladies to Ridgewood Pumping Station, Brooklyn. Visit to Prospect Park and Greenwood Cemetery.

By invitation of the Commissioners of Department of City Works and Robert Van Buren, Chief Engineer, a visit was made to the famous pumping station of the Brooklyn City water works, located on Atlantic Ave., by way of Brooklyn bridge, Fifth Ave. Elevated railroad and Long Island railroad, a distance of eight miles from New York city hall. Two hours were spent in examining the old and new engines, and many interesting features were observed in relation to pump construction since the year 1858 to 1892.

The party returned to the junction of Atlantic and Vanderbilt ave. and thence by a short route, reached the Montauk Club House, located on Prospect Park heights. This club house is delightfulty located and is unsurpassed for its elegant appointments, its membership comprises some of the leading men of the city. Mr. J. B. Edson and Charles A. Moore, members of the Local Committee, and members of the club were enabled officially, to extend an invitation of the courtersy of the club to the members of the Association and the ladies. Elegant music and an equally elegant lunch was provided. The Hon. Daniel A. Boody, mayor of the city, in an able address on the subject of Brooklyn's present and future prosperity, extended a cordial welcome to the Association. His Honor felt the importance and appreciated the influence of the Association's work, he was glad of the opportunity and the occasion that brought us together.

The city of Brooklyn manifested a kind interest in the visit of the Association members to the city, by the presence of John P. Adams, Esq., Commissioner Department of Parks; Van Brunt Bergen, Esq., first Assistant Engineer, Department of City Works and other prominent officials. Charles A. Moore of the Local Committee prefaced his introduction of Mayor Boody to the Association by a few happy remarks concerning the advantage of club life and its influence upon the wives of club members.

The party after inspecting the rooms of the handsome club building and indulging in the pleasure of an informal reception in the drawing room, entered carriages and proceeded a short distance to Prospect Hill Reservoir, "a point of vantage" 200 feet above tide water from which could be viewed the lower part of New York City, New York Bay, the Narrows, the Ocean, the famous seaside resorts at Coney Island and Rockaway, after which they were driven through Prospect Park and Greenwood Cemetary, thoroughly enjoying the unsurpassed natural landscape scenery, as well as the ornamental and architectural effects associated therewith.

On Saturday, by an invitation from the National Meter Co., through its genial President, John C. Kelley, a member of the Local Committee, an all day excursion was accepted. The party embarked upon a fine steamboat of the New York Steamboat Co., at Pier No. 1, North River and proceeded up the Hudson river as far as Hastings, a distance of 20 miles, affording a magnificent view of the Palisades and scenery of the lower Hudson, returning thence, passing the upper bay of the harbor of New York City, viewing all points of interest, not forgetting the Bartholdi statue and landing at the foot of 44th street, South Brooklyn, pro-

ceeded to the new factory of the National Meter Co., a short distance from the landing. This factory of extensive proportions was nearing completion, its size and construction was the admiration of the party, and the impression made convincing them that meter construction was an important factor in the catalogue of water works supplies. After an inspection of the factory, including some of the machinery the party proceeded to the upper floor of the building and partook of an elegant and substantial repast that satisfied the most hungry as well as the most fastidious in the matter of epicurican taste. The party re-embarked and in a short time were landed at the point of starting. The day was rainy, but notwithstanding, the attendance was large. A fine band discoursed music. The "young and old, the grave and gray" tripped the light fantastic toe and although cheerless as the weather proved to be all went "merry as a marriage bell." No one regretted the excursion, though regretting the weather. It proved conclusively that the genial president of the National Meter Co. could make the best out of an excursion and that so far as the elements were concerned on that day "on the water," "and the water over us," it made no difference, for none of the party enjoyed themselver better than John C. Kelley of "Kelley's Island fame" did to see his friends and guests enjoying the full measure of the hospitality and good cheer of the National Meter Company.

The Local Committee are indebted to Charles A. Moore and George Bramwell and others for their valuable aid and counsel, and last, but not least to the wives, daughters and lady friends of the Local Committee members in their successful efforts to promote the comfort and pleasure of our lady visitors.

In Memoriam.

During the past fiscal year of the Association, we have sustained the loss of four of our active members by death.

L. Halsey Williams, Secretary and Treasurer Water Works, New Castle, Pa.

Edward Armstrong, Supt. Water Works, Allegany City, Pa.

Nicholas Kuhn, President Water Works, Davenport, Ia.

Charles Elliott, Supt. Spring Valley Water Works, San Francisco, Cal.

LIST OF MEMBERS.

AMERICAN WATER WORKS ASSOCIATION.

HONORARY.

Y. Nakajima, Imperial University.....Tokio, Japan

ACTIVE.

Abbott, E. L., Hydraulic Eng.....403 Temple Court, New York, N. Y
Aldridge, Geo. W. Water Com.....Rochester, N. Y
Alexander, W. A., Sup't Penna. Water Co.....Wilkinsburg, Pa
Allen, Chas. Fred., Treas. Water Co.....Hyde Park, Mass
Alsterlund, J. F., Ch'f Eng. Water Works.....Moline, Ill
Andrews, M. L., Sup't Water Co.....Arkansas City, Kan
Artingstall, Samuel G., Civil Eng.....Chicago, Ill
Ayres, H. W., C. E. Water Works.....Hartford, Conn
Ayres, Sylvanus, jr., Mgr. Water Works.....Bound Brook, N. J
Babcock, S. E., C. E. Water Works.....Little Falls, N. Y
Bailey, D. A. B., Sup't Water Works.....Findlay, O
Ball, Phineas, Hydraulic Eng.....Worcester, Mass
Barnard, W. W., Executive Committee.....Rochester, N. Y
Barnet, Jno., Sup't Water Works.....LaFayette, Ind
Barrows, F. C., Chairman Water Com.....Minneapolis, Minn
Bement, R. C. B., Ch'f Eng. Duluth Water Co.....St. Paul, Minn
Benzenberg, G. H., Ch'f Eng. Water Dep't.....Milwaukee, Wis
Bergstrom, Andrew, Mechanical Eng. Water Works..Minneapolis, Minn
Birkinbine, Harry.....Philadelphia, Pa
Bishop, E. H., Sup't Water Works.....Wahpeton, Dak
Bogart, John C. E.....71 Broadway, New York City
Bolling, Chas. E., Sup't Water Works.....Richmond, Va
Bond, Joseph A., Ch'f Eng. Water Dep't.....Wilmington, Del
Booker, Geo. E., Ch'f C. S. V. W. W. Co.....San Francisco, Cal
Brackenridge, G. W., Pres't Water Co.....San Antonio, Tex
Bramwell, Geo. W., C. E. & Contractor...59 Wall St., New York, N. Y
Bristol, W. H., Recording Gauge Co.....Hoboken, N. J
Brooks, Isaac W., Pres't Water Co.....Torrington, Conn
Brower, Edw. A., M. E. Water Works.....Lyons, N. Y
Brown, A. L., M. E. Water Works.....Salem, Oregon
Brown, Calvin S., with Hersey Meter Co.....Toledo, Ohio
Brown, E. H.....Grass Valley, Cal
Brown, Milton A., Sup't Water Co.....Perth Amboy, N. J
Brundage, W. H. Sup't Water Works.....Bridgeport, Ala
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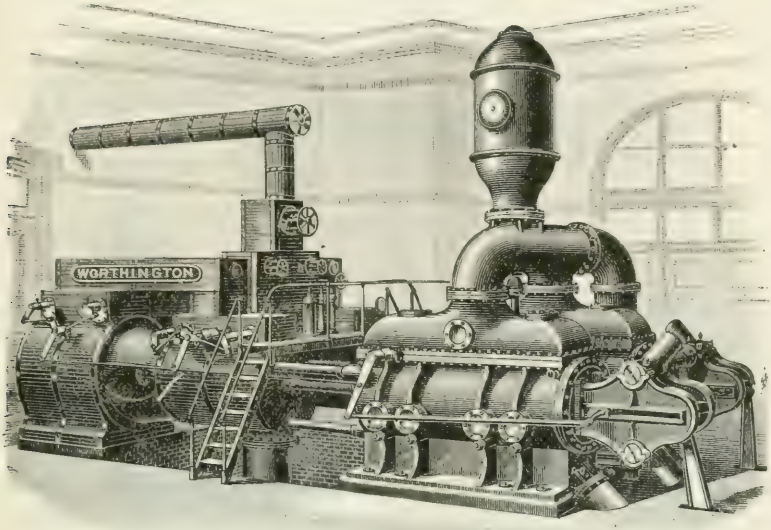

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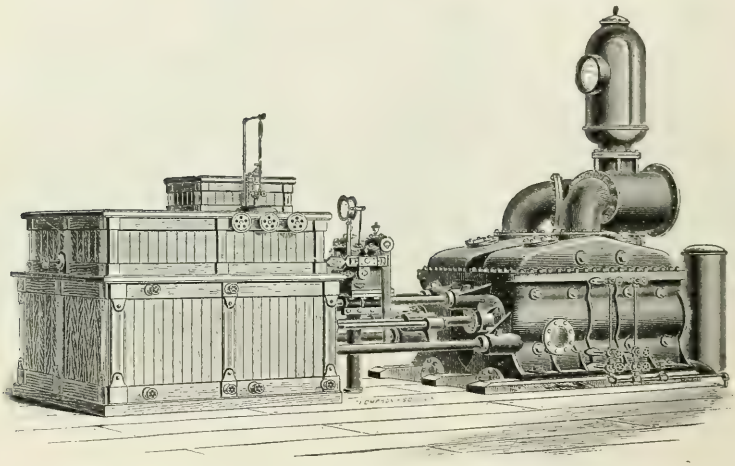

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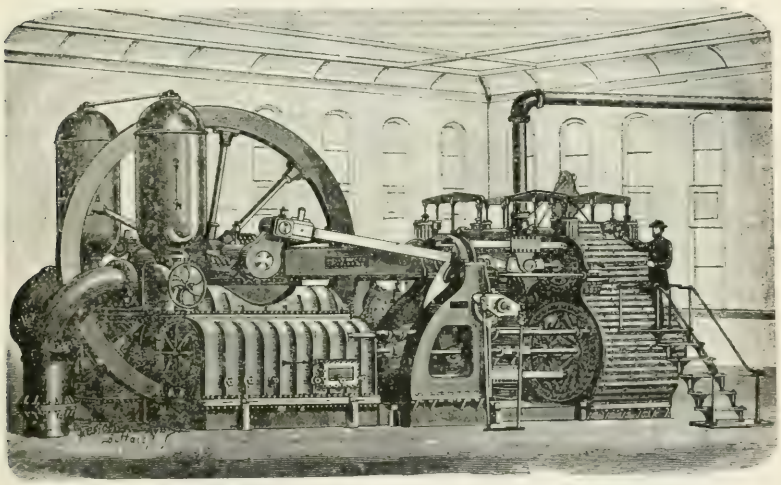

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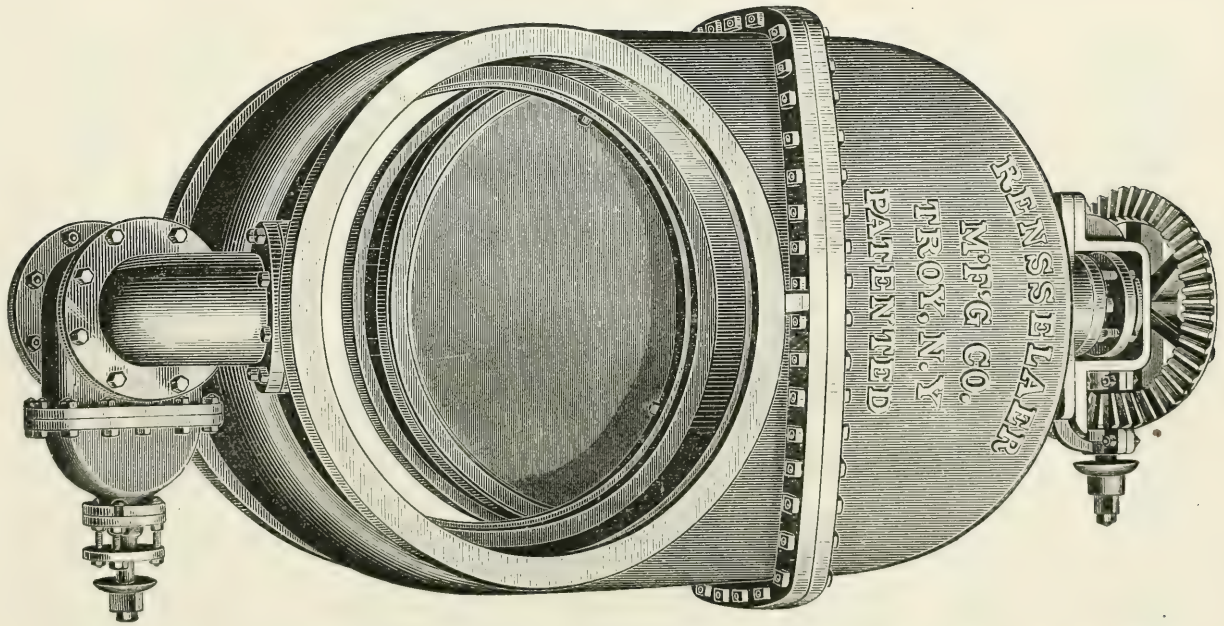

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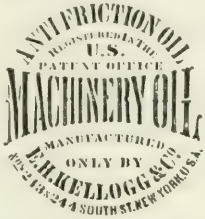
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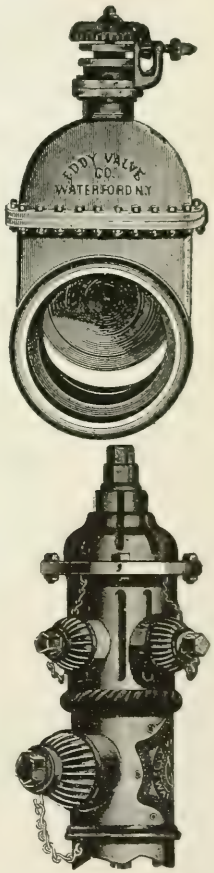

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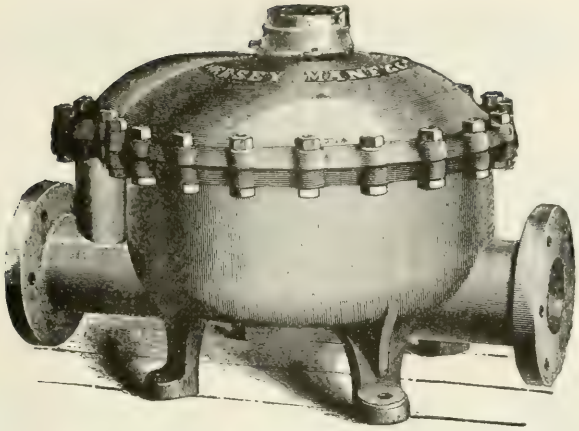

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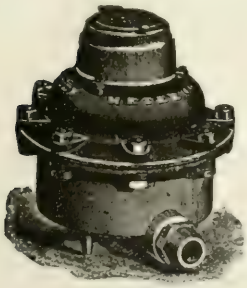

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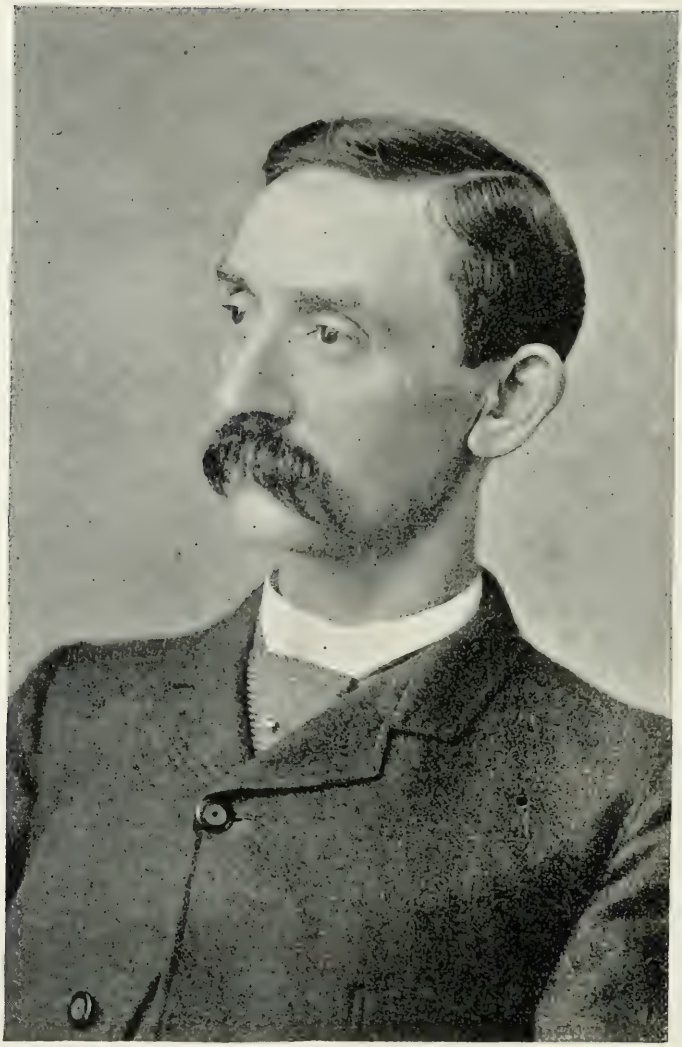

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REPORT OF PROCEEDINGS

OF THE

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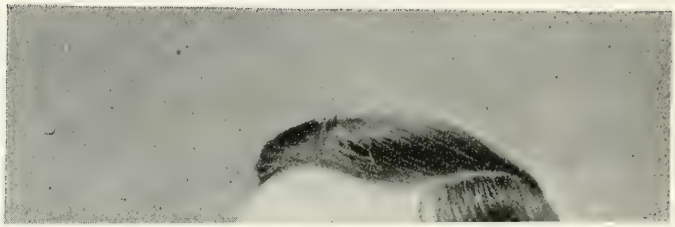
Elmira, New York.

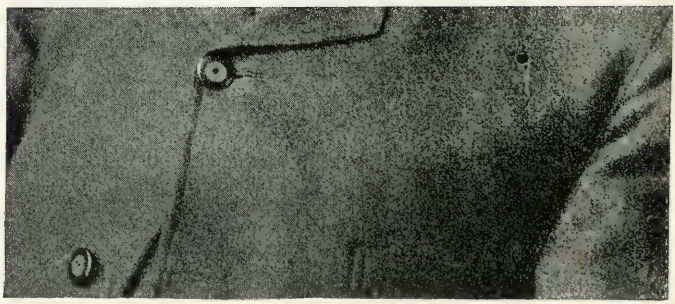
Please Acknowledge Receipt.

HELD AT

CHICAGO, ILLINOIS,

MAY 20TH, 21ST AND 22D, 1890.





J. N. Decoux

REPORT OF PROCEEDINGS

OF THE

TENTH ANNUAL MEETING

OF THE

American Water Works Association,

HELD AT

CHICAGO, ILLINOIS,

MAY 20TH, 21ST AND 22D, 1890.

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TENTH ANNUAL CONVENTION

OF THE

AMERICAN WATER WORKS

ASSOCIATION,

HELD AT

Chicago, May 20-24, 1890.

FIRST DAY.

MORNING SESSION, Tuesday, May 20, 1890.

Meeting was called to order by the President, Mr. J. H. Decker, in the Ladies' Ordinary of the Grand Pacific Hotel at 10 o'clock A. M., who said :

Gentlemen, I have the pleasure of now calling to order the tenth annual convention of the American Water Works Association. Mr. Linneen, the chairman of the local committee of arrangements, I believe has a word to say.

MR. LINNEEN : Gentlemen of the convention, we have met here for the tenth time in this great city of Chicago, and judging from the upturned faces to this elevated platform, I predict that this will be one of our best meetings. Unfortunately the Mayor of the city, who has been identified with the water works department for forty years of his life, is absent, but he will be ably represented here by the Comptroller, Mr. Onahan, who is Mayor pro tem. of the city in his absence. The Mayor has sent a letter of regret which I will hand to the Secretary to be read to the convention. I take great pleasure in introducing to you Mr. Onahan, our Comptroller and Mayor pro tem.

MR. ONAHAN: Mr. Chairman and gentlemen, I have a brief and pleasant duty to perform this morning in the absence of His Honor, Mayor Cregier, who, as you have been informed, was called away from the city. It is my duty to welcome you in his name and in the name of the municipality, and I am sure I may add in the name of the entire people of the city of Chicago. We are glad, gentlemen that you are here to deliberate upon a matter of so vital and so important concern to this municipality, an interest which touches every home and every manufacturing interest, and touches widely and deeply this and every other municipality in the United States. Chicago is glad to welcome every interest here, and I assure you of such hospitality as its hotels and the generous hearts of its people can give, but I am especially glad to welcome you because if there is anything that this city at this time is desirous to be informed about, to reform and to improve, it is its water works system. I need not inform you, gentlemen, of the great problem that is put upon this city in connection with the World's Fair that is to be held here in a few years, and of the importance it is for the growth of the city, for the glory of the State, and the pride of the Nation that it shall be in all respects the model municipality, as we claim it to be the future great metropolis of the United States. Hence we do not doubt from your deliberations and from your practical information upon this subject which touches us so deeply that we can derive much profitable information, and I need not say to you, gentlemen, how alert the people of Chicago, how quick the manufacturing interests of this city and its people may be to receive and adopt any reforms and improvements in our system that you may be able to suggest. I know, gentlemen, you are practical men of affairs in business, and hence such a thing as a protracted speech would be odious, and a speech of welcome ought always to be brief. I wish I could interpret more eloquently the welcome that would have been accorded to you by His Honor, the Mayor, who has so long been practically familiar with this work; but I assure you that it was his desire that you should be received with such warmth of welcome as would appeal to every heart here, and to assure you that Chicago feels a very warm interest in you. I can only say in conclusion,

gentlemen, as I said at the outset, that you are warmly welcome, and in the name of the municipality and the people of Chicago I give you that assurance as forcibly and powerfully as I can. [Applause.]

MAYOR'S OFFICE, CHICAGO, May 19.

Mr. J. H. Decker, President, and Members of the American Water Works Association:

GENTLEMEN—A brief absence from the city to meet an engagement made prior to receiving notice of date of holding your Convention in Chicago deprives me of the pleasure of welcoming you in person and conveying thanks for the cordial invitation to be present, so kindly communicated by your committee.

Permit me, however, to express a warm appreciation of the courtesy extended, and to assure you and your co-laborers of the high respect and consideration entertained by the writer for a body of men, whose professions and callings constitute a conspicuous and absolutely essential factor in an advanced and progressive civilization.

Within the domain of beneficent and bountiful nature lies hidden the crude elements, which, when brought forth by the genius and design of the engineer, and other kindred professions, and are fashioned, moulded and prepared by the skilled and devoted artisan, contributes largely to the domestic necessities and sanitary comforts of life.

Thus do science, art and mechanics occupy the front rank in the world's advancement.

Inability to mingle with you on so important an occasion and renew many old and valued acquaintances is especially regretted by the writer, because of the deep interest I feel in the special branch of engineering so ably represented by your association, a branch in which I have devoted, in an humble way, nearly forty years of my life.

Gentlemen, I shall but voice the people of Chicago when I officially extend to you, one and all, a hearty welcome to our metropolis, and express the hope that your deliberations may be harmonious and profitable, and that your sojourn in our "fair" city may be such that you will carry away pleasant memories of the tenth annual meeting held in Chicago, and insure your return in 1893 to exhibit the result of your labors to the people of the world.

Meantime we will leave you in the hands of the local committee, Messrs. Linneen, Guilford, Dalzell and Prentice, who are hereby authorized to furnish, free of cost, a full supply of what the name of your association would imply to be your favorite beverage, "water."

With renewed assurances, respect and esteem I have the honor to be,

Yours truly,

DEWITT CREGIER, Mayor.

THE PRESIDENT: Mr. Onahan, on behalf of the American Water Works Association I desire to extend to you, sir, our heartfelt thanks for your kind and courteous attention, and through you to the Mayor the same thanks for this hearty welcome. We are here, Mr. Onahan, as business men. We have met here to do busi-

ness. We hope during the time we may spend with you that we may so deport ourselves and our actions may be such that you will be glad to see us again. I will say further that I hope that you, Mr. Onahan, and all the city officers will spend as much time with us as possible. Our meetings are open and we would be glad to have you here. We give you a cordial welcome to all our meetings.

Upon call of roll by the Secretary the following members responded :

ACTIVE.

Ayers, H. W.....Hartford, Conn.
Abbot, E. L.....South Bend, Ind.
Barrows, F. C.....Minneapolis, Minn.
Benzenberg, G. H.....Milwaukee, Wis.
Bond, Joseph A.....Wilmington, Del.
Bowen, William.....Davenport, Ia.
Brown, Calvin S.....Boston, Mass.
Bull, William B.....Quincy, Ill.
Brown, Milton A.....Perth Amboy, N. J.
Barnard, W. W.....Rochester, N. Y.
Callahan, A. F.....Louisville, Ky.
Cameron, W. L.....Memphis, Tenn.
Clark, D. M.....Elyria, Ohio.
Cloud, J. A.....Jacksonville, Fla.
Darling, Edwin.....Pawtucket, R. I.
Decker, J. H.....Salina, Kas.
Denman, A. N.....Des Moines, Ia.
Diven, J. M.....Elmira, N. Y.
Donahue, J. P.....Davenport, Ia.
Dunham, H. F.....Cleveland, O.
Ellis, Robert N.....Jacksonville, Fla.
Foote, C. M.....Minneapolis, Minn.
Fritchman, W. H.....Peoria, Ill.
Frost, E. W.....Colorado Springs, Col.
Fry, D. C.....Jacksonville, Ill.
Fish, J. B.....Scranton, Pa.
Gardner, L. H.....New Orleans, La.
Guilford, A. J.....Chicago, Ill.
Hague, Charles A.....New York, N. Y.
Hamilton, W. S.....Youngstown, O.
Harley, P. M.....Fort Madison, Ia.
Herion, J. W.....Minneapolis, Minn.
Holden, H. G.....Nashua, N. H.
Holly, Frank W.....Lockport, N. Y.
Hood, Charles.....Burlington, Ia.
Hooper, Thomas N.....Davenport, Ia.
Horneing, George.....Newport, Ky.
Jackson, F. M.....Oak Park, Ill.
Jones, R. M.....Kansas City, Mo.

Jones, J. I. ..... Kansas City, Mo.
Judson, Charles A. ..... Sandusky, O.
Keeler, H. E. ..... Chicago, Ill.
Knickerbocker, John ..... Troy, N. Y.
Laing, W. H. ..... Racine, Wis.
Lakin, John T. ..... Rockford, Ill.
Leeds, Albert R. ..... Hoboken, N. J.
Linneen, P. H. ..... Chicago, Ill.
Lyman, I. L. ..... Lincoln, Neb.
McAlpine, A. H. ..... Columbus, O.
Milne, Peter, Jr. ..... New York, N. Y.
Molis, William ..... Muscatine, Ia.
Monjean, C. ..... Cincinnati, O.
Moore, A. G. ..... Cincinnati, O.
Neville, Thomas J. ..... Rochester, N. Y.
Potts, Isaac B. ..... Columbus, O.
Priddy, Charles N. ..... Leadville, Col.
Page, J. B. ..... Lynchburg, Va.
Richards, W. G. ..... Atlanta, Ga.
Root, W. J. ..... New York, N. Y.
Russell, S. B. ..... St. Louis, Mo.
Ryle, William. ..... Patterson, N. J.
Sawyer, J. T. ..... Waverly, N. Y.
Sheppard, F. W. ..... New York, N. Y.
Sprague, W. W. ..... Town of Lake, Ill.
Stookey, M. T. ..... Bellville, Ill.
Safford, J. P. ..... Chicago, Ill.
Tilden, James O. ..... Boston, Mass.
Tubbs, J. Nelson ..... Rochester, N. Y.
Walsh, M. T. ..... Minneapolis, Minn.
Watts, W. H. ..... El Paso, Texas.
Wilkerson, J. H. ..... Bowling Green, Ky.
Willard, W. H. ..... Eau Claire, Wis.
Wills, E. S. ..... Atchison, Kas.
Wirt, R. D ..... Independence, Mo.

ASSOCIATE.

Bingham & Taylor ..... Buffalo, N. Y.
Blake, George F., M'f'g Co ..... New York, N. Y.
Bourbon Brass and Copper Works ..... Cincinnati, O.
Caldwell, John A. ..... Bay Ridge, N. Y.
Chapman Valve M'f'g Co ..... Indian Orchard, Mass.
Clark, William L. ..... Newark, N. J.
Clow, J. B. & Sons. ..... Chicago, Ill.
Columbus Water Works. ..... Columbus, O.
Dean Steam Pump Co. ..... Holyoke, Mass.
Deutsch, William M. ..... New York, N. Y.
Eddy Valve Manufacturing Co. ..... Waterford, N. Y.
Edson, Jarvis B. ..... New York, N. Y.
Fisher Governor Co. ..... Marshalltown, Ia.
Galvin Brass and Iron Works ..... Detroit, Mich.
Gordon Steam Pump Co ..... Hamilton, O.
Hall Electric Pump Co ..... Plainfield, N. J.

Hays Manufacturing Co.....Erie, Pa.
Hersey Meter Co.....Boston, Mass.
Holly Manufacturing Co.....Lockport, N. Y.
Hyatt Pure Water Co.....New York, N. Y.
Illinois Malleable Iron Co.....Chicago, Ill.
Jewell Pure Water Co.....Chicago, Ill.
Jones & Laughlin.....Chicago, Ill.
Jewell, O. H. & Sons.....Chicago, Ill.
Kellogg, E. H. & Co.....New York, N. Y.
Long, Dennis & Co.....Louisville, Ky.
Ludlow Valve Manufacturing Co.....Troy, N. Y.
Marsh, W. H.....New York, N. Y.
Morgan, A. W., Manufacturing Co.....Buffalo, N. Y.
Mott, J. L., Iron Works.....New York, N. Y.
Mueller, H.....Decatur, Ill.
National Meter Co.....New York, N. Y.
Payne, W. S.....Fostoria, O.
Rouse & Hills Co.....Cleveland, O.
Rensselaer Manufacturing Co.....Troy, N. Y.
Shickle, Harrison & Howard Iron Co.....St. Louis, Mo.
Spiral Weld Tube Co.....East Orange, N. J.
Union Water Meter Co.....Worcester, Mass.
Water Waste Prevention Co.....New York, N. Y.
Wood, R. D. & Co.....Philadelphia, Pa.
Worthington, H. R.....New York, N. Y.

The following applications for membership were read by the Secretary :

ACTIVE.

1. Alexander, W. W., Sup't Penn'a Water Co.....Wilkensburg, Pa.
2. Afsterlund, J. F., Chief Engr Water Works.....Moline, Ill.
3. Armstrong, Edw., Sup't Water Works.....Allegheny City, Pa.
4. Baird, G., Physician.....Wheeling, W. Va.
5. Bailey, D. A. B., Sup't Water Works.....Findlay, O.
6. Cahill, Stephen A., Sup't Water Works.....Manistee, Mich.
7. Dudley, Geo. W., Mechanical Engineer.....St. Louis, Mo.
8. Glore, W. H., Sup't Water Works.....Covington, Ky.
9. Griffin, A. D., Sup't Water Works.....Frankfort, Ky.
10. Hawkins, Robt., Chf Engr 68th St. W. W.....Chicago, Ill.
11. Haynes, Jos. E., President Aqueduct Board.....Newark, N. J.
12. Jones, C. A., Asst Sup't Water Works.....Kansas City, Mo.
13. Kelley, Jno. C., Director Water Works.....Brooklyn, N. Y.
14. Maxwell, Jas. R., Consulting Engineer.....Cincinnati, O.
15. Mitchell, W. C., Sup't Water Works.....Janesville, Wis.
16. Nichols, C. M., Sup't Water Works.....Madison, Wis.
17. Northway, Wm. R., City Engineer.....Chicago, Ill.
18. Owen, Jas., Sup't Water Works.....Montclair, N. J.
19. Paige, J. B., Sup't Water Works.....Lynchburg, Va.
20. Parkin, R. R., Sup't Water Works.....Elgin, Ill.
21. Partridge, N. A., Treas. Rogers Park Water Co.....Chicago, Ill.
22. Pierson, Geo. H., Consulting Engineer.....New York, N. Y.
23. Prentice, Allen T., Mechanical Engineer.....Chicago, Ill.

24. Raymond, H. S., Sec'y the Galena Water Co.....Chicago, Ill.
25. Rider, Jos. B., Hydraulic Engineer.....South Norwalk, Conn.
26. Rider, W. B., Hydraulic Engineer.....South Norwalk, Conn.
27. Rumsey, Israel P., Director Carlinville W. W.....Chicago, Ill.
28. Schrop, Ira S., Sup't Water Works.....South Bend, Ind.
29. Sevier, S. Q., President Water Works Co.....Camden, Ark.
30. Sickles, F. E., Chief Engr Water Works.....Kansas City, Mo.
31. Smith, Anthony P., Supervisor Water Works.....Newark, N. J.
32. Smith, Erastus G., Consulting Chemist.....Beloit, Wis.
33. Spaulding, Z. S., Sup't Water Works.....Fort Payne, Ala.
34. Straw, Lafe W., Sup't Water Works.....Danville, Ill.
35. Sullivan, J. F., Sup't Water Works.....Sioux City, Ia.
36. Tracy, Thos. H., Sup't Water Works.....London, Ont.
37. Wing, Geo. B., Cashier Water Works.....Kansas City, Mo.
38. Wright, Millard F., Sup't Water Works.....Lowell, Mass.
39. Yardley, Thos. W., Bureau of Inspection.....Chicago, Ill.

ASSOCIATE.

1. American Filter Co.....Chicago, Ill.
2. Hinds, A. Jr., Tuerk Hydraulic Power Co., 39 Dearborn Street.....Chicago, Ill.
3. Paul, A. G., Fairbanks & Co., 311 Broadway.....New York, N. Y.
4. Spiral Welde Tube Co.....East Orange, N. J.
5. Western Valve Co., 166 Lake Street.....Chicago, Ill.

It was moved and seconded that the rules be suspended and that the Secretary cast the vote of the Association for the foregoing applicants.

Carried.

PRESIDENT'S ADDRESS.

Gentlemen of the American Water Works Association:

The tenth annual meeting of our organization opens to-day in this the great metropolis of the west, a city marvelous in itself, the product of energy and perseverance of her people. A city although twice devastated by fire, each time losing almost the entire business centre; yet, phœnix like, she has arisen from her ashes, in greater grandeur and magnificence than ever, peerless in her might and well worthy to entertain the world's greatest gathering, the quadri-centennial anniversary of the discovery of the country. We are met here to-day in annual convocation under exceedingly pleasing and favorable auspices. But few of you present to-day remember that exceedingly disagreeable 29th day of March ten years ago, when twenty-two determined spirits met in the engineers' hall of Washington University, St. Louis, and organized then and there the American Water Works Association. Of the obstacles encountered and overcome many of you are aware, however these are but retrospects to those who have participated in the struggles and successes of our early years. To-day this association is the representative water works association of the world, with a membership, a name and influence reaching from "Greenland's icy mountains, to India's coral strand."

The original membership of twenty-four, representing twelve water companies and departments has increased to over 300, representing nearly 200 different companies and departments. This membership is

not alone confined to our own glorious union, for we have reached over the border and grasped the hands of our Canadian brethren. A little farther and we greet one off in lonely Newfoundland; across the ocean, in the mother country, we claim another; thence with a mighty stride we greet our brothers in far off India and the flowery isles of Japan. We are engaged in an industry ranking in importance second to none—that of distributing the greatest and most useful of the God-given elements. We have dependent upon us millionaire and mendicant, manufacturer and mechanic; none so rich, none so poor as to be able to live without us. We hold within our grasp the health, the safety and the prosperity of the great cities of the nation. Our calling is a high and noble one.

We convene here to-day, gentlemen, in annual meeting for the purpose of conferring together, comparing notes and experiences, and hearing written and oral opinions as to the best methods of improving, extending and conducting our business, not only for our own benefit, but for the benefit of the communities we serve. For in serving our respective communities to the best of our ability, we improve and strengthen our own business, between the water consumer and the water supplier there is a mutuality of interest; each has rights which the other should respect but alas! too often is it the case that this fact is lost sight of—too often is it the rights of the supplier, particularly in the cases of private control of the water plant, that are not recognized.

There exists in this country to-day an almost universal prejudice against corporations, which is no doubt more bitter against water companies than any other corporate bodies—not necessarily because their sins are greater than those of others, but because they are brought into more direct contact with the masses. The fact that a water company in the conduct of its business is compelled to place its property wholly under the control of the consumer, and to be largely dependent upon his honor and integrity for its use, necessitates the framing of a code of laws or rules, and the imposition of conditions which to the average mind seem to be arbitrary and exacting. The trend of public sentiment is growing largely toward the socialistic. The restraint or abridgement of what the people are pleased to term their rights and liberties, is particularly obnoxious and will not be brooked.

But are the consumers to be held wholly responsible for this state of affairs? Are not the water companies to a certain degree responsible for the public sentiment for or against it? The very nature of our business necessitates a monopoly; therefore we should so conduct it as to cause as little friction and oppression as possible. This can in a great measure be accomplished by the careful avoidance of any discrimination, either in the way of rates or privileges; by straightforward and firm, but courteous enforcement of such reasonable regulations as will protect both the interests of the company and the consumer; by exercising leniency and forbearance where the infraction or transgression is merely technical; by the avoidance of all disputes and contention with consumers and city authorities; by meeting all charges and complaints in a kindly and conciliatory manner; and by always remembering that, "He that ruleth his own spirit is greater than he that taketh a city." It is doubtless true that "the average city council * * * is a most uncertain quantity." Invariably there are one or more members of that body whose highest ambition is to erect a monument to themselves by antagonizing all corporations and monopolies doing business with the city, but by pursuing

the policy above outlined, and cultivating genial and friendly intercourse with all, you remove their strongest weapons, largely remove the public prejudice against you, and strengthen and fortify your company against opposition.

Permit me to suggest that, although many of us have given the best years of our lives and the most earnest devotion of which we have been capable to the advancement of our profession, still we are none of us masters, in the sense that there is nothing for us to learn. We are yet students, willing to learn from those who can teach, and to profit by the experience of others. Whatever we may learn is not for ourselves, but for the interests of the people and those whom we serve. On the principle that "he who makes two blades of grass grow where only one grew before is a national benefactor," so it is that in our profession, as indeed in any other, he who by his study and devotion contributes to the comfort and convenience of the people, confers a national benefit. Out of the labors of this association there ought to grow, and there is growing, a higher appreciation of our work, and I look forward with confidence to the time when our labor will be recognized and accepted as one of the agencies tending to the elevation of our national character.

We are here, gentlemen, as representatives of a business interest, which involves the very highest sanctions of science, and the best convenience of the people. We are proud of our calling, yet we have duties devolving upon us of the greatest importance. It is not sufficient that we take the waters of our rivers, lakes and ponds and deliver them to our consumers, charged with all their natural and acquired impurities, but it is our duty—a duty which we owe alike to ourselves and our customers—to furnish this most necessary of all the necessaries of life in the purest and best obtainable state, to free that which we are furnishing from every taint and harmful impurity, ever remembering that we may be, unwittingly, the agents in spreading some direful epidemic, while, on the other hand, it is within our power to confer the greatest of blessings upon the nation.

Such is our chosen mission. We have voluntarily made ourselves students in this work, and while we are in the discharge of our duties as such, there can be nothing too simple nor yet too abstruse for our examination. If, then, the most modest among you thinks he has some new plan or suggestion to offer, let him boldly explain it here and we shall take great pleasure in discussing it as becomes earnest business men, that out of our deliberations may come that which we all seek, "the greatest good of the greatest number." If any one has a question to ask or a knotty problem to present, upon this floor is the proper place to make it known, for such is the purpose of this organization.

The past decade has been one that will ever be remembered in water works history. The growth in number of plants has been little short of miraculous. There were in 1881, the date of our organization, in the United States, 626 water works. In Canada, thirty-one. There are to-day in the United States 1820 plants, and in Canada eighty, an increase of 200 per cent., or twice as many as were constructed during the preceding century. The capital invested is about $500,000,000, the annual revenues closely approximating $50,000,000, while the length of the mains is nearly 30,000 miles, with over 2,000,000 of taps.

Let us mark too the progress in other directions in our line. This same period has given birth to the mechanical filter; it has given most

marked improvements in our pumping engines; a higher degree in the efficiency of the meter and a degree of excellence in all classes of supplies hitherto only hoped for. To those of us whose experience dates back into the decades prior to the last, the progress is wonderful, and we have but entered upon this age of progress. Those of us who may be spared —and it is the sincere wish of your chairman that it may be every one present to-day—to meet at our next decennial gathering, will have in their various works appliances beyond anything now thought of. The great demand of to-day is a satisfactory meter, and a satisfactory means of filtration and I apprehend with confidence that through the effort of this association, the time is not far distant when we shall have both. This is a part of the work we have in hand, and it behooves us to bend every energy to secure its fruition.

It is stated in our annual circular, "As each year rolls 'round we are more strongly impressed with the necessity of united effort to place the business of water supply upon a higher plane, and of conducting it upon a more uniform and systematic basis." That such is the case not a gentleman upon the floor will deny. Then, may I ask, why is it that of the 1900 water works in the United States and Canada less than ten per cent. are represented in this association? At a low estimate fifty per cent. should be enrolled, and there should be 500 active, zealous managers upon this floor to-day. It certainly cannot be said that our association has not been widely advertised and its aims and objects made known, nor can it be urged that local organizations are supplying the want. There is a lack somewhere. Is it that the individual members take no interest in building up the ranks? or is it not rather more largely due to the indifference of boards of commissioners and directors and to the fact that they will not or do not make it obligatory upon the managers to attend, and that they do not provide for the expense of so doing? For it cannot be expected that the managers of the smaller plants will pay their own fees and dues, with the additional expense incidental to our annual gatherings; they cannot afford it from their salaries. Let us endeavor then to impress upon those most deeply interested in the success of our association the necessity for their cordial and financial support. Thanking you heartily for the honor conferred upon me, I believe I may safely rely upon your assistance to make this, the tenth annual meeting, as successful in every particular as were its predecessors.

REPORT OF EXECUTIVE COMMITTEE.

To the Members of the American Water Works Association :

GENTLEMEN : Your Executive Committe would respectfully report :

That they have fixed the salary of the Secretary and Treasurer at $350.00 for the past year, and have authorized him to draw a warrant for that amount.

We have examined the design presented by the Badge Committee and recommend that it be adopted as the Badge of the Association.

We would recommend that all members delinquent in their dues for three or more years be dropped from the roll, with privilege of reinstatement at any time upon payment of all arrearages.

Respectfully submitted.

J. H. DECKER, Prest. for Executive Committee.

Chicago, Ill., May 20th, 1890.

REPORT OF SECRETARY AND TREASURER.

To the Officers and Members of the American Water Works Association:

GENTLEMEN: I have the honor to submit herewith the Tenth Annual Report of the Secretary and Treasurer of the Association.

Since our last meeting we have lost from our ranks by death, Ex-President, J. G Briggs.

During the year we have gained 40 Active and 3 Associate members; we have lost by resignation 2 Active members, dropped from the rolls for non-payment of dues 16 Active and 2 Associate, leaving a net gain of 23 members. There are now enrolled 1 Honorary, 247 Active and 64 Associate, a total of 312 members.

CASH STATEMENT.

Balance on hand last report		$23 08
Rec'd from Admission Fees	$245 00	
" " Annual dues	689 00	
" " Sales of Proceedings	8 40	942 40
Total from all sources		$965 48

Disbursements:

Paid Warrant 45, in favor of P. H. Linneen, Engraving Gaskell Memorial	$ 8 00	
Paid Warrant 46, in favor of A. G. Welsher, printing circulars and envelopes	6 35	
Paid Warrant 47, in favor of Wells, Fargo & Co., Stenographer's report	79 35	
Paid Warrant 48, in favor of A. G. Welsher, electrotype plates Tomlinson's paper	22 50	
Paid Warrant 49, in favor of A. G. Welsher, on account of printing proceedings	50 00	
Paid Warrant 50, in favor of A. G. Welsher, balance for printing 9th Annual Report	169 45	
Paid Warrant 51, in favor of J. H. Decker, office expenses and postage	58 70	
Paid Warrant 52, in favor of Elmira Telegram, stationery and notices to delinquents	7 75	
Paid Warrant 53, in favor of Elmira Advertiser Association, letter heads for Vice Presidents	4 00	
Paid Warrant 54, in favor of Elmira Advertiser Association, receipt book, etc	11 50	
Paid Warrant 55, in favor of Elmira Advertiser Association, programs, etc	18 50	
Paid Warrant 56, in favor of J. M. Diven, Sec'y, office expenses and postage	47 47	
Paid Warrant 57, in favor of J. M. Diven, Secretary, salary	350 00	
Balance cash on hand	129 91	
		$965 48

REPORT OF FINANCE COMMITTEE.

We, the Committee, have examined the Report of the Secretary and Treasurer, and find the above report to agree with the books.

Finance Committee { WM. MOLIS. / JAS. P. DONAHUE.

THE PRESIDENT: I will announce to the members that since the last annual meeting, the death of our old friend and past president, John G. Briggs, has occurred.

MR. CAMERON: Mr. President, this death removes another of the originators of the Association, and one of its most earnest supporters. As a member and friend no one could excel him. His heart was as young and cheerful as that of a boy, and the idea that we will never see him here and grasp his kindly hand again gives me much sorrow. I believe that his death leaves yourself and myself the only members of the society who met ten years ago.

THE PRESIDENT: I have here a letter from Mr. Briggs' sister, which the Secretary will read.

INDIANAPOLIS, May 11th.

MR. DECKER—My brother-in-law, John G. Briggs, died at 6 o'clock this A. M., May 6th, after an illness of six months. About three weeks ago he said to me, will you write to Mr. Decker for me, I want to dictate a letter to him, but he was too weak that morning. I asked him if there was anything special he wanted to say to you, he said, yes. I would like to ask him to write my Obituary. His mind was somewhat cloudy for a month before his death, result of general weakness, so this request might have been a fever fancy, but he spoke of it often—thought it best to write you—as his wife says he was very fond of you, and frequently spoke of you. Another illustration of ruling passion strong in death, as almost his last rational talk was of Water Works people. He was greatly attached to his profession ; his quaint humour was strongly manifest all during his illness. He had an attack of malarial fever early in the fall followed by La Grippe, which so exhausted him he never rallied. He was decidedly impressed from the first that he would never get well. I would be pleased to give you any information you require.

325 N. Noble St. MISS LUCY HEISKELL.

MR. DARLING: It was with feelings of great sorrow that I learned yesterday of the death of Mr. Briggs. It is truly said that he was one of the originators of this Association. A year before the meeting at St. Louis he corresponded with me, and we had correspondence backwards and forwards as well as with Mr. Stripe, our late associate. I can say that Mr. Briggs was an earnest

man in this Association. He was one of those men who had his whole life in it. He was very kind, very affable, and very pleasant to me and I can only say that I regret his demise from this Association.

The following resolutions were offered by Col. L. H. Gardner :

Resolved, That in the death of our brother and past president, J. G. Briggs, the American Water Works Association has sustained a most serious loss. From the earliest days of the Association's existence up to the time of his last illness, the services he rendered the organization, the valuable papers he contributed at the annual meetings, and his sage counsel and advice made him one of our most valued and prominent members, while his genial temperament and open heart endeared him in a peculiar manner to every one who enjoyed the privilege of his acquaintance.

Resolved, That the hearty sympathy of this Association is hereby tendered to his widow and family, with the regret that words are so inadequate to express the depth of our sympathy and sorrow in their bereavement and ours.

Resolved, That these resolutions be spread upon the minutes and a copy be sent to Mrs. Briggs.

The motion that the resolutions be adopted as read was carried by a standing vote.

The President: I desire to say that two of the St. Louis members have died within the last six weeks : Carroll E. Gray, who resigned his membership sometime ago, died very suddenly at Waukesha, Wisconsin, in the early part of April.

The President: Next in order will be the report of the committee on electrical boiler devices.

Motion that the report of the committee be received; carried.

Mr. Bull: I did not know that it would devolve upon me to open the practical work of the convention. There was such a committee appointed at the Louisville convention and I was appointed as its chairman. The committee consisted of Mr. Denman, Mr. Jones of Kansas City, Mr. Linneen and Mr. Donahue of Davenport. I endeavored to get that committee together. It was to meet at Quincy, my home, but with indifferent success, I am sorry to say the gentlemen composing it were not able to get there at one time; but I succeded in getting Mr. Jones to visit Quincy and I was also paid a

visit by Mr. Donohue, and showed these gentlemen the device that was under some little discussion at the last convention and they inspected the interior of my boiler. I believe they would say if they were asked, that they found these boilers in very good order, but about that time I got switched off from the idea that I presented to you at the last convention, and did not think it necessary that that committee should undertake to formulate a report. I also received a communication from the Secretary of the Association, and he asked me to prepare a paper on the subject, which I have done, and which, if the convention desire, I will present in lieu of the report of that committee. If that is the wish of the Association and they are ready to hear it I will read a paper on the subject, which merely represents what that committee would have have said if they had come together, perhaps, upon the subject.

Motion that Mr. Bull be allowed to read his paper, carried.

MAGNETIC BOILER CLEANERS.

BY WILLIAM B. BULL.

Some weeks ago I was requested by our Secretary to present a paper to this Convention on the subject of "Cleaning Boilers by Electricity." By means of *magnetism* should have been the title of what I have to say, as electricity may or may not be a direct factor in the operation.

Those of you who were present at the convention at Louisville may recall some statements there made by me, descriptive of a device which I had gotten up for use on my own boilers, and which had done good work for quite a period. It consisted, you may remember, of an electro magnet attached to the mud drum of a boiler, another electro magnet attached to the steam drum, and an iron yoke connecting the two magnets, which magnets were excited or made active by a current of electricity generated by a small dynamo, which in its turn was operated by a small Tuerk motor.

Some one asked what my theory was concerning the operation of this device, and I said that the best theory I had been able to devise was that the operation was a mechanical one, the result of rapid polarization and depolarization of the boiler by means of an interrupted or alternating current, setting up something like a vibration in the shell and tubes, which prevented a lodgment of scale upon their surfaces, the mineral being kept, as it were, dancing like a grain of sand upon a drum-head. I stated also that an eminent electrician had concurred with me in this view of the matter.

The month after the convention, however, I stumbled upon a paragraph in a newspaper giving an account of some chemical changes which had been observed to occur in the field of a magnet, by a Californian

named Frazer, and which he had turned to account by inventing a machine for *ageing* wines and spirituous liquors, that is to say, he produced in wines, etc., by the action of powerful electro magnets, those changes which had heretofore only been attained by age or patient waiting. His method was to place the wine in tanks which were surrounded by great coils of insulated wire; he then passed a current of electricity over his coils of wire, and thus established a strong magnetic field in the space which they included, which was occupied by the wine, the effect upon the wine being distinctively noticeable.

Here was a decided suggestion that the operation of magnets upon steam boilers was not a mechanical but a chemical one, and that it was the water in the boiler, and not the boiler itself, which was affected. I accordingly constructed a simple device, consisting principally of a tubular or hollow electro magnet, operated by a dynamo as heretofore, through which hollow magnet the feed water was made to pass on its way from the feed pump to the boiler. Fortunately I was able to attach this apparatus to a bran new boiler, and after nearly a year of use it has been pronounced by the inspector, on his subsequent and recent inspections, as being entirely free from scale, both shell and tubes. This is one of my own boilers and part of a battery which has given more or less trouble from scale until I began employing magnetism as a preventive.

A wish to still further simplify this machine and to render it perfectly automatic and independent of attention on the part of the engineer, led me to experiment in the direction substituting permanent steel bar magnets as a source of magnetic energy, in place of the more complicated dynamo and the electro magnet; so that as I now prefer to construct the machine, it consists of an iron cylinder ten inches in diameter or less, dependent upon the service it is to render, and about twelve inches long. This cylinder is strong enough to resist all reasonable pressure, has flanged heads and is set on the feed pipe, preferably before the feed water enters the heater, (if there is one), as a current of very hot water flowing over the magnets, which are kept in position by the cylinder, is weakening to them. Water of the temperature of 100 degrees or less does not impair the strength of the magnets, which, if treated in accordance with a few easily met conditions, may be considered as substantially indestructible.

The life of a compass needle may be cited as a type of their probable durability. The magnets are arranged within the cylinder just referred to, in sheafs or bundles; they are made of straight bars of hard steel, (not horseshoe in shape), are somewhat separated, to allow of their proper relation to each other and to permit an uninterrupted passage of the feed water. In a cylinder of the size referred to, 10 inches in diameter, there are about 150 magnets made of ¼-inch steel one inch in width and of varying lengths, from three to ten inches.

The apparent effect of the process, that is to say, of passing the feed water through an intense magnetic field thus produced, is to change the relation previously existing between the water and the mineral impurities held by it in solution, so as to destroy their scale producing properties, and the mineral impurities seem to be thrown down to the bottom of the boiler in what I call "slush." For example, an excellent opportunity for a test presented itself in the shape of a boiler in use in a lime burning establishment near Quincy, Ill., the boiler in question being fed from a well at the edge of a limestone quarry, the water being perfectly clear, and to the eye free from organic matter and all visible im-

purities, but under the usual well-known tests for such things showing excessive and unusual hardness, even for well water in a limestone region; it was in fact so bad that the tubes in this particular boiler are renewed twice a year, as a rule, on account of the scale which forms on them.

The proprietor of this boiler told me that in cleaning it every fortnight he usually found some loose scale in the bottom, which unequal expansion and contraction had detached, and a small quantity, less than a handful, of what looked like sand. After the use of the magnets for ten days, a heaping shovel full of this sand or disintegrated scale was taken out, and after two more weeks not less than three shovels full of the same was removed, mixed with fragments of friable scale. This was at the last cleaning, about ten days ago. The boiler, I ought to say, was a small upright boiler from 6 to 10-horse power, and the scale which they were in the habit of removing was as hard as Portland cement. It broke with difficulty and had almost a cutting edge. In contrast to this the scale which came down under the action of the magnet was so friable that it crushed easily between the fingers and could be reduced in one's hand to the condition of fresh mortar or plaster, it being, of course, wet when first taken from the boiler. Inside the boiler, reaching through the hand-holes, it could be scraped off the shell with bare fingers, much as one would scrape fresh mortar or plaster from a newly plastered wall.

The soft material and sand-like deposit which was found in the bottom of this boiler was quite free from any mixture of mud, as the feed water was perfectly clear, and the deposit afforded excellent opportunities for examination. Under a microscope the particles seemed to be crystalline in structure, the crystals having more length than breadth, like fragments of dogtooth quartz.

The scale that was thrown down, if carefully handled, on account of its great friability and weakness, presented under a strong glass the most interesting illustration of what was taking place. The best comparison that I can think of is a block of ice which has stood in the sun until it has become, as we say, "needled," and is ready to break up in long spiculæ or needles, something we have all seen a thousand times. So it appeared with these scales. A little pressure with the finger on the palm of the hand would reduce them to the sandy particles which made up the mass of what came out of the boiler. Scales from the same boiler and feed water, it should be noted in this connection, before the use of the magnets were like hard, fine-grained sandstone, and showed under the glass a homogeneous structure. In a word, the action of the magnetized water upon the scale already formed in this boiler, and also in another very dirty boiler to which I successfully applied the magnetic purifier, was to destroy the "bond" of the scale so that it became weak and rotten like worthless mortar or cement, and in condition to readily disintegrate and fall down in slush or fine particles under the action of the currents in the boiler or otherwise.

I am sorry, on some accounts, that I am called upon to read a paper of this sort to this Convention at this time. It is only about three months since I began experimenting with the particular form of magnetic device the operation of which I have just referred to, and such experiments being made, not in a laboratory, but upon steam boilers, that must go from a fortnight to a month before the experimenter can see whether he is on the right track or not, necessarily takes a good deal of time.

If I had had six months longer to experiment in this matter, with

different waters and under varying conditions, I should probably have had material for a more interesting and exhaustive paper, but enough has already occurred under the critical and sceptical observation of myself and others to make it apparent that in the field of a magnet certain chemical changes of a practical utility to steam users do occur, affecting some, and perhaps all, waters carrying minerals in solution, and that with a good deal of confidence one may say that another useful application of electricity, or its associate, magnetism, has been added to the daily lengthening list.

The President: The report of the committee is now before the convention for discussion, and Mr. Bull will be ready and happy to answer any questions which persons may wish to propound in relation to his device.

Mr. Denman: I move you, sir, that Mr. Bull be continued a committee on that same subject, and I hope that he will present a report at our next annual meeting upon the subject. Seconded.

Mr. Donahue: I desire to second Mr. Denman's motion, and I want to say in connection with this paper that I had the pleasure of visiting Quincy and arrived there at a very opportune time to investigate this electrical device, as Mr. Bull's pumps were not in operation and I had a very good opportunity to look into the boilers, and I must say that while I have not seen a great many boilers, this particular boiler that I looked into at Quincy was one of the cleanest boilers that I ever saw, and in fact, it was just as clean as a brand new boiler, and the water which Mr. Bull was using was regular Mississippi water, and I presume nearly all of you know what that is in boilers. The idea that presented itself to me, and I asked Mr. Bull the question whether or not the action of the current causing the tremor in the boiler shell, had any effect upon the boiler. As I understood it the action was to create a slight tremor or trembling, preventing the scale forming on the shell. Now I understand that Mr. Bull has taken another method of treating the scale and avoids this objection, if it was any objection to the apparatus, but I would like to ask Mr. Bull, without detaining the convention this morning, whether or not he has ever made any experiments with artesian water in boilers. Now, artesian water composed of sulphur and magnesia is water that is very hard on boilers, as I presume anybody who has

had any experience in that line has found to be the case, and I would like to know whether he has been able to make any experiments on artesian water with this electrical device.

THE PRESIDENT: Before answering the question the Chair will state that there is a motion before the house which should be properly disposed of. The motion of Mr. Denman is, that Mr. Bull be continued as a committee of one for the next annual convention. Carried.

MR. BULL: I understand Mr. Donahue's question to be, whether I had any experience in treating artesian well water. I have not. My experiments so far have been largely confined to waters impregnated with carbonate of iron and magnesia. From his remarks I infer that lime was present in the artesian water in the form of sulphate of lime. I have had no experience with water containing sulphate of lime. I have no reason to suppose that it would be affected any different from carbonate of lime, although it may be.

MR. ELLIS: I would like to state that I have been experimenting chemically on the same line that Mr. Bull has electrically, and use one pint of kerosene oil every day in a boiler fed with artesian water and the scale, nearly a quarter of an inch thick, has been removed from that boiler in the last year. The suggestion was first made by my pumping engineer, Mr. Hubbard, and he has been using kerosene oil every day, injecting it with the feed water. The old scale has been removed from the boiler and it has prevented any more scale from forming. That artesian water, contains both sulphate of iron, sulphate of soda and sulphate of magnesia.

MR. OWEN: I would state that in coming in on the train I was talking to the superintendent of a soot mill and he told me it was his practice to use kerosene to clean his mills for the same purpose that Mr. Ellis has stated.

DR. LEEDS: Gentlemen—This paper of Mr. Bull's which was published in your journal for last year interested me, perhaps, more than anything that was said in that little journal, and it called to my mind the fact that a number of years ago, I think fully twenty-five years

ago, this whole subject of the use of magnetism in the prevention of scale occupied very much at that time the engineering journals, and if you will turn back to the reports of the Franklin Institute, about that time there are one or more papers relating to the subject. The Franklin Institute had the matter formally brought before it and appointed a special committee which consisted of many eminent engineers and they worked upon the problem at that time. The apparatus that was in use at Philadelphia at that time consisted of a large number of permanent magnets; not electro magnets such as is described in your journal of last year, but a number of permanent magnets, and these were inserted through the crown of the boilers, the crown sheet, and attached to the forward end of the boiler. It was stated as the result of many experiments at that time that the whole interior of the boiler was kept entirely free from scale. The matter interested the large firm of engineers at Philadelphia, of Morris and Tasker to such an extent that they took hold, investigated and formed a company for the development of the work, and they were so encouraged by the result that they sent a gentleman to France and asked the co-operation of Mr. Becquerel and De la Rive, two of the greatest engineers at that time in France, and obtained a report which in itself, substantially appears favorable. They ascribed it to a condition of polarity which prevented the deposition of the scale. Unfortunately, these results were never brought to a satisfactory conclusion. There were some of the engineers including Mr. Sellers of Philadelphia, one of that firm of extensive builders who never felt himself warranted on the evidence presented to take a favorable view of these results, and certain it is that when, at the close, this committee which was appointed by the Franklin Institute to make a report were asked to make that report at the special wish of Morris and Tasker, who were the principal promoters of the enterprise at that time, the report was withheld and has never appeared in print, and that I think was the termination of this investigation at that time, although it stirred up a great deal of activity and I have been told caused the patenting of a vast number of devices for affecting this work at that time.

MR. BULL: The remarks of the gentleman who has just spoken are of especial interest to me; they are new to me. The records of the patent office show that there have been a great many attempts to accomplish this thing by methods which have some points of similarity, which have a good many things in common. The favorite method of attempting to do this is by an electrolytic process using a current of electricity. There have been so many patents issued for processes depending for their operation upon the electrolytic principle which have never come to anything so far as I can see that I have never had much confidence in the operation of any such principle. The use of magnetism as opposed to electrolysis has, in more than one instance, been successful in doing this thing. You remember that I stated to the convention at the last meeting, that my attention was directed to this thing, by the partial success of the operation of some device which was sold to me; but it had within itself the elements of such short life and such speedy destruction that it could not be relied upon for any durability, consequently I tried to modify these defects and get something that would not be subject to this defect. The method that the gentleman has just spoken of is glaringly defective in the point to which I allude. It must of necessity be extremely short-lived because anyone who has even dabbled in this subject a little knows that there is nothing more certainly fatal to the strength and operation of a permanent magnet than any degree of heat above that which we are accustomed to find in the atmosphere. You take a lot of permanent magnets in the shell of a boiler and subject them to a temperature of three hundred degrees and in twenty-four hours they are so much scrap iron and nothing better. It is quite possible that the apparatus to which he refers may have been tried for a very brief period by the committee so as to encourage those who were behind it that it would be a successful method; but as he describes it it is obvious enough that it must of necessity be of very brief life. Another difficulty in the past has been as I gather from the patent office records, which is my best means of knowing what other people have been doing, and that is that in dealing with the whole boiler you have got to go into the boiler; and you have got to shut down before you can get the information, and people don't

like to have their boilers tampered with too much. I have done this by working with the feed water, instead of attempting to dabble with a whole battery of boilers at once. And furthermore I am certain that in order to be successful, and I may say that I have been successful in my experiments so far as I have gone with them, I have found that I have got to treat the feed water at some point in the feed pipes where it was cold, that is moderately cold; not after it left the heater. In this point alone if no other, there would be a very essential and valuable difference between what I am talking about and the matter which was brought before the Franklin Institute, as this gentlemen says a quarter of a century ago.

The President: The next thing in order will be the report of Mr. Linneen, Chairman of the local committee.

Mr. Linneen: The local committe on arrangements have provided what they consider a very pleasant programme for the entertainment of the members of this Association. On Thursday we shall have to adjourn our business meeting temporarily; this room will have to be used for the regular dining room in order to have the large dining room prepared for our banquet. Thursday afternoon there will be carriages at the door for the conveyance of all the members of the Association to the Harrison street Pumping Works and the North Side Pumping Works and Lincoln Park and the Lake Shore drive. The members of the Association will be landed on the pier on the north shore where tugs will be in waiting to take them out to the tunnel on the North Side and the tunnel at Fourteenth street. There will also be a very fine exhibition given by the fire tug Geyser, which is one of the most powerful fire tugs ever built. Thursday evening we will have our banquet. There is an invitation here from Mr. Rumsey to take a special train to Elgin, Illinois, for the purpose of examining the watch works there, the greatest in the world I believe, as well as the water works. The train will leave the Northwestern depot at 8:30 a. m. There will be carriages at the door here to take you to the train and meet you there on your return, about one o'clock, which will give ample time to see what is to be seen in Elgin. After lunch Friday there

will be a special train waiting at Van Buren street on the Illinois Central railroad to take you to Pullman. Mr. Pullman has invited us to visit Pullman, and he will have a representative there to show us through the various establishments. We will return on the special train to South Park where carriages will be waiting and we will be driven through Jackson Park and South Park drives and back to the hotel via Michigan avenue. That is the programme for Friday which I trust will be carried out. On Wednesday afternoon, I forgot to mention, you will be invited to an examination of the great Auditorium Building, which will perhaps be as pleasant a part of the entertainment as any. Now, if the programme is too lavish or more than you think we can get through with it will be as well to have it known in time. I think, however, that the schedule is so arranged we can get around very nicely.

Mr. Cameron : My opinion is that business should go before pleasure. We are, of course, very much obliged to the local committee for their desire to please us, but we ought to attend to our business. I think we can do both by having night sessions, and we can see the Auditorium individually. Leave that part of the programme out and I think we can finish all the rest ; but we certainly ought to attend to the business we came so many miles to attend to.

Mr. Tubbs : I suggest that as the committee of local arrangements and the people of Chicago who have so kindly offered us entertainment desire us to see all we can of the city and its environs that we hold an evening session this evening and read a portion of to-morrow's papers. Do up our business fast and take it all in. I offer that as a motion. Carried.

Adjourned.

Afternoon Session, Tuesday, May 20th, 1890.

Meeeting called to order by President Decker at 2:30 p. m.

The President : The next order of business is the report of the committee on Standard Cast Iron Water Pipe, of which committee Mr. Russell is chairman.

REPORT ON CAST IRON WATER PIPE.

To The American Water Works Association :

Mr. President and Gentlemen :—Your committee on standard water pipe recommends that the association adopt a series of sizes for cast iron water pipe, to be known as the American Association standard. We think that the classification shown in the attached table would answer present needs, and that the consumers of the larger part of the pipe used in the country would be suited within its range. If found to be desirable, the classification could be extended in the future so as to include heavier and lighter pipe. The main points of the proposed series are : First, there are three classes to be designated by the letters A B and C respectively for each size of pipe. The weight of class B pipe was determined from the average weight of the pipe used in a large number of American cities and towns. Class A pipe weighs ten per cent. less than the average class B, and class C pipe weighs ten per cent. more than class B. Pipe more than five per cent. heavier than the average class B should be classed as C pipe, and pipe more than five per cent. under weight should be classed as A pipe. The maximum class C pipe is five per cent. heavier than the average, and the minimum class A pipe is five per cent. lighter than the average class A. Thus if a twelve-inch pipe weighs more than 1095 pounds it is class C ; if less than 1095 pounds, and more than 961 pounds, it is class B and C. The maximum and minimum weights, per each class of each size, are given in the tables. For the sake of uniformity, the length, not including bell of each pipe, should be twelve feet.

It is the belief of your committee that if some such series of sizes should receive the endorsement of this Association and the support of its members, that it would soon come into general use and would then be found of great convenience. Every pipe foundry in the country should have a copy of the table, as finally adopted, so that if it received, for example, an order for 100 tons A eight-inch it would be understood the eight-inch pipe weighing not less than 627 pounds per length were wanted.

Size.	Class.	Outside Diameter in inches.	Ave. Thickness of Barrel in inches.	Weight per 1,000 Feet Laid. Pounds.	Weight for Length, Including Bell, 83⅓ Lengths. to Lay 1000 Feet.		
					Average.	Maximum.	Minimum.
3	A	3.856	.428	14,000	168	178	160
	B			15,580	187	196	178
	C			17,170	206	216	196
4	A	4.904	.452	19,170	230	243	218
	B			21,330	256	267	243
	C			23,500	282	296	267
6	A	7.000	.500	31,330	376	397	357
	B			34,830	418	439	397
	C			38,330	460	483	439
8	A	9.094	.547	44,750	537	567	510
	B			49,750	597	627	567
	C			54,750	657	690	627
10	A	11.190	.595	60,570	727	768	691
	B			67,330	808	848	768
	C			74,080	889	933	848
12	A	13.286	.643	78,250	939	991	892
	B			86,920	1,043	1,095	991
	C			95,580	1,147	1,204	1,005
16	A	17.476	.738	119,170	1,430	1,510	1,359
	B			132,420	1,589	1,668	1,510
	C			145,580	1,747	1,834	1,668
20	A	21.666	.833	165,330	1,984	2,105	1,885
	B			183,750	2,205	2,315	2,105
	C			202,080	2,425	2,546	2,315
24	A	25.856	.928	220,750	2,649	2,796	2,517
	B			245,250	2,943	3,090	2,796
	C			269,750	3,237	3,398	3,090
30	A	32.142	1.071	316,250	3,795	4,006	3,650
	B			351,420	4,217	4,428	4,006
	C			386,580	4,639	4,871	4,428
36	A	38.428	1.214	428,750	5,145	5,431	4,888
	B			476,420	5,717	6,003	5,431
	C			524,080	6,289	6,603	6,003
48	A	51.000	1.500	710,670	8,528	9,002	8,102
	B			789,670	9,476	9,950	9,002
	C			868,670	10,424	10,945	9,950

Mr. Cameron: I think this matter ought to be discussed thoroughly. Pipe makers claim that they test all their pipe up to three hundred pounds pressure, no matter what the thickness of it is. It has been intimated that water companies in the past have been putting too much money in the ground; that a light pipe tested up to the pressure of three hundred pounds to the square inch is just as good as a heavy one, and I would like to say something on this point. I would like to ask the President to call upon some of the members by name who are present and who have sat in these conventions year after year and whom we know are fully competent to speak. I would like to ask the President to call upon them and ask their opinion on every paper that is read.

The President: It is hardly within the province of the President to do that. It is within the province of any member to call upon any other member.

Mr. Richards: Mr. Cameron's remarks would lead a person to think that a test of three hundred pounds pressure is the only strain that is put upon a pipe. It is a very nice theory to adopt to test the pipe by three hundred pounds pressure, but you have got other things to take into consideration. There are times when the pressure runs up to five hundred pounds and the pipe has got to stand that. And then you have got to make provision for water hammering.

Mr. Cameron: Mr. Linneen remarked at the last meeting in Louisville that there was no such thing as water hammering.

Mr Tubbs: I am in the position of my friend from Atlanta. I am not prepared to make a scientific speech on this subject, but want to say a few words about it. I have not heard the paper that has been read. It is my misfortune, but I have one or two practical suggestions to make. In any test that I have made on pipes where I send an inspector to the pipe foundry I require several things. Now I have seen pipes tested at three hundred pounds to the square inch, and I have stood off a little distance and seen the spray, the finest imaginable, coming through, when you got in the right direction with the sunlight and while it did not burst under the pressure, the sudden, quick, short pressure that is made, yet I am

satisfied it was a poor pipe. The finest spray imaginable could be seen in the sunlight coming through the pores of iron that was not homogenous. Now my plan is this; I require an inspector to take a steel pick, about three pounds in weight, and the moment the pipe comes from the mould and is rolled out on the skids he takes the steel pick and strikes on every part of the pipe and if there is any part of the pipe that is not homogenous the pick will go through it, and so far as the water hammering is concerned, my friend Linneen to the contrary notwithstanding, there comes a pressure, nobody knows what it amounts to, it may be twelve hundred pounds to a square inch, and any good water pipe ought to stand it. Every good water pipe ought to stand it, yet the pick inspection will detect whether it will or not. Let your inspector go through the whole of the pipe and if there is any imperfect part of it, anything that is not homogenous in the iron it will go through it and make a hole in it. That is the thing to do, and the pick inspection is worth more than all your hydraulic inspection of three hundred pounds pressure. I have been a great many years in this business and I would rather take the pick inspection, such as I have described, followed by the hydraulic inspection than all the other inspections you can make.

Mr. Cameron: I am under the impression that Mr. Tubbs does not understand my proposition. I wanted to know whether a perfect casting one inch thick that would stand a pressure of three hundred pounds to the square inch, was not just as good as one an inch and a quarter thick.

Mr. Tubbs: I will say to the gentleman and the convention that, of course, engineers decide on certain thicknesses for certain sizes of pipe. If you want a four inch pipe they say it should be so thick; but they mean by that that after you have tried every pick inspection and every hydraulic inspection that it shall stand your pressure without trouble. There is another element that enters into large pipe, and that is the element of transportation. You may take large pipe and try to transport it and it may stand all these inspections and it wont stand the transportation; jarring of cars and everything of that sort. You have got to have a certain thickness for transportation and there is the third element in the

case. First, whether it will stand a hydraulic pressure of three hundred pounds; second, whether it will stand a steel pick inspection; third, whether it will stand transportation. Now my idea about the whole business is this; the engineer cannot determine to a nicety what can be done in any single case; but he has got to be in consultation with the manufacturer, and the manufacturer takes in the transportation question. He knows just what the shaking up and the jarring of cars and everything of that sort amounts to, and he says if you will take it a certain thickness I will take the chance of the transportation, then the engineer can take the chances after his pick inspection and his hydraulic inspection. There is the whole thing in a nut shell.

Mr. Cameron: That is just the point I wanted to get at. Circumstances govern the case, so that you cannot make a standard weight of pipe to be adopted.

Mr. Linneen: My name has been taken in vain by some of these gentlemen that have been talking on this subject. It has been said that I stated at the Louisville convention that there was no water hammer; but I stated there that the water hammer was largely a myth, and I still adhere to that theory. It is an unknown quantity. It is something that will do for gentlemen to talk about when they come to these conventions and substitute it as a cause for other defects in pipe lines. Now I think there is one safe way of purchasing pipes from the manufacturer, and the quicker the purchaser of pipe comes down to that principle the better it will be for his service. I have in my time laid a good many miles of pipe and purchased a good many hundred miles of pipe, and in every instance that I have purchased pipe I have declined the three hundred pound hydraulic test at the works. I say to the manufacturer you can apply that test or not as you choose. I shall send no man to your works to see that you put on that pressure. I don't care whether you put it on or not; but if you want to sell me that bill of pipe I require that after it is laid in the trench that it shall be subjected to a pressure from the pump of one hundred and fifty pounds to the square inch; that is the test that I require of a manufacturer, and those tests have been generally successful. I apply

the pressure from the pumps and if a piece of that pipe comes out of the ground under that pressure they pay the cost of replacing it; and if you will adopt that rule instead of a pressure at the works, as usual, you will obtain better results. Now it is a well known fact that the general effect of the pressure that is applied at the factory on waterpipe is to close the pores in the iron. It is closely pressed from each end the pressure put onto it is instantaneous. They watch the needle of the gauge and just as quick as it comes to the spot they apply the pressure. After the pipe is laid in the trench I subject it to one hundred and fifty pound pressure, and every piece that I have broken under that pressure the manufacturer of the pipe has paid for. I found it very difficult last year when I bought a lot of pipe to get a manufacturer that would do this. Two manufacturers refused to make that guarantee, but I found one that made it; and the sooner the purchasers of pipe apply that test the better it will be.

Now as to water hammering I am not prepared to say but what that cuts some figure in the distribution of water in the pipes. I think it does to a certain extent but as I said before it is an unknown factor. It is beyond the comprehension of any one. I have concluded that the water hammer is largely exaggerated, and my experience with pipes that have been tested in the trenches under a pressure from the pumps of one hundred and fifty pounds is, that I have very rarely had any further trouble with it either in the joints or the pipe itself.

Mr. Tubbs: Mr. Chairman, I do not desire to occupy the time of this convention, but this is a very important matter. Now if a large amount of pipe is to be bought by a water company or a city, I still believe that it is best to send an inspector, who knows all about the business, to make the steel pick inspection, and not only do that, but see the kind of iron that is put in it and watch it from the inception to the end. A pipe may come out that is like glass. It will stand a thousand pounds pressure perhaps. By-and-by you want to cut it up to make a connection and you will find it as hard as glass. It is a very difficult thing to cut it; it cracks and it makes all sorts of trouble. You want to

see that you can cut it up and do anything you have a mind to with it and still have strength. I believe if you have a large amount of pipe to buy for a city or a private corporation or anybody else that you should send an inspector to the works and have all these tests made right on the spot. I agree with Mr. Linneen that you must make the most stringent possible test and make the manufacturer responsible if the pipe fails. Now I am here to say as I shall say later in this convention, that we ought to hold the manufacturer of metres responsible for them. Pay the manufacturer whatever he charges for making the meter; pay him for whatever he charges for making a permanent piece of pipe, but throw the responsibility on him as Mr. Linneen has suggested.

Mr. Linneen: I am going to join issue with Mr. Tubbs on this question. It is a well known fact that all the manufacturers of the country who furnish water supplies of almost any kind, whether it be a hydrant or a valve or a pumping engine or a metre, have to make a certain guarantee as to their adaptability for the service as well as their durability. Now the same is true of the pipe manufacture. There is a vast amount of capital invested in the manufacture of pipe, and the practice is that just as soon as that pipe leaves the manufacturers his responsibility ceases. The purchaser has to take the chances of testing the pipes at the shops as well as the dangers consequent upon transportation. Now it is all very well, gentlemen, to send an inspector to the shops and hammer this pipe and test and pick it if you please, but my experience has been, and I dare say it has been the experience of many of the gentlemen who are within the sound of my voice, that before that inspector spends two weeks in the city of Cincinnati, Louisville, St. Louis, Philadelphia, Buffalo, or any of those manufacturing cities that he will pay very little attention to the testing of pipe. He has got other duties to attend to. He is feasted, pampered, wined and otherwise indulged, and in a short time he becomes disqualified for the duties he is to perform. I think that is the experience of all of you. Now I claim that the responsibility for the manufacture of the pipe should not cease when that pipe leaves the factory any more than the responsibility of

the manufacturer of the valve ceases when that valve leaves the factory. Now there is only one safe way and it is a pretty sure way, because the manufacturers of pipe have set their faces solidly against it, that is to test this pipe in the trench, and I trust that that will be the future test of pipe. Test it in the trench ; test it where you have got to use it ; and when you put it there and subject it to that test you can feel pretty sure that it is reliable in the future. I have blown pipe that was submitted to three hundred pound test out of the trench under one hundred and fifty pound pressure ; pipe that was laid with care ; but the manufacturer should require the purchaser to handle that pipe carefully in unloading it from the cars and subjecting it to the hammer test before putting it into the trenches. There are two sides to the question, and I think it is an injustice to the manufacturers, that have guaranteed their work right along, to be called upon to compete in the manufacture of pipe with those that are released from their guarantee as soon as some one sees three hundred pounds pressure put on to the pipe at their works. They claim that their responsibility ceases there ; that even if it bursts in the trench you have got to take it up and replace it at your own expense.

This is one of the most prolific subjects for discussion that will come before the meeting, and I would like to hear the views of all the gentlemen here.

Mr. Benzenburg : It seems to me in this discussion we are losing sight of one fact, and that is that the engineer determines the conditions and specifications and the manufacturer makes his pipe according to the specification. If the manufacturer is to assume all the responsibility, what is the use of the engineer ? The engineer understands, having charge of the works, the conditions under which that works is to be operated, under what pressure the pipe is to be placed, and to what shock it may be subjected. That is not the business of the manufacturer. The manufacturer agrees to furnish the stock of a certain class of material specified, of certain thickness, uniformly cast. If the pipe does not withstand the shock or hammer test it is not the fault of the manufacturer if his material is all right ; but the failure of the engineer in not designing the proper size for the

pipe. The pipe should be, to my mind inspected at the works, first as to the material used by the manufacturer in making the pipe, the quality of iron, whether it has sufficient tenacity or whether it is brittle and will break at a shock. The pipe subjected to a three hundred pound pressure at the works is supposed to stand all the test that the pipe in the trench will have to sustain, and I cannot see but what you are putting your manufacturer again at a disadvantage when you require him to assume the responsibility of the laying of the pipe in the trench, in addition to having manufactured the pipe according to specifications. A great deal of fault in breaking of pipe is on account of the manner in which that pipe is laid or supported. Now your pipe is subjected when in the trench to a pressure of one hundred and fifty pounds. If you will submit that pipe to a pressure of three hundred pounds or a pressure of one hundred and fifty pounds it must stand that test, and take it in sight of the inspector, not buried in the ground where you won't see it; where you know nothing about it only as there is an upheaval. The pipe is, as I understand it, put under a quiescent pressure of three hundred pounds to the inch; when under that test it is submitted to a sharp shock of the hammer. And why? You all know that iron can withstand a certain quiescent strain, but the minute you put it under vibration or a shock it is liable to break if it hasn't tenacity to withstand it. That shock, I take it, caused by the hammer is a test as to the brittleness of that pipe. Now the quiescent test aims to reproduce that which Mr. Linneen thinks is a myth, the hammer. The inspector is in the service of the water department that sends him there, and I think is expected to do his duty as well as any one else at the works or at home. And I am sorry to hear it admitted by the representative of a manufacturing firm that the inspector is liable to be pampered and wined and dined. There are such cases, and I have myself observed them, and if the pipe returns poorly made and the pipe is carefully inspected upon its receipt in the city, I think the parties can soon ascertain whether the inspector is attending to his duties or whether he is receiving the hospitalities of the manufacturer. I know that such has been done. I have had to discharge summarily inspectors at the works when I found that they

were being dined and wined. I don't think, therefore, that you can adopt a standard pipe that will do for all conditions and circumstances. The conditions of the cities may so vary that what is good pipe and a pipe of proper weight for one city is not for another city. And that is a matter for the engineer to determine and one of the objects for which he is engaged, to determine those points. If under the ordinary low pressure a standard pipe is wanted, why, an adoption of such sizes as submitted by the committee would be all right. There is something further than that needed. And that is the specification for the conditions under which the pipe is to be placed and a rigid inspection at the works. If the inspection is rigid I don't think that any one would have occasion to complain of the bursting of pipe unless conditions may arise for which the engineer has not made provision in the specification.

Mr. Linneen: After this pipe has received the inspection of a faithful inspector and it comes to your place and you give it a further inspection and see that it is not cracked in transportation; you put it into the trench and you apply pressure, it may be of fifty or one hundred pounds, and the pipe bursts. Who pays for that expense? Who stands that loss?

Mr. Benzenburg: I never heard of such a thing.

Mr. Linneen: I have, lots of times.

Mr. Benzenburg: I never heard of a case where pipe that has been tested under three hundred pounds pressure at the works gave out at one hundred and fifty or even two hundred pounds in the trench. I don't see why it should. Your pipe on the bench is submitted to three hundred pounds hammer test.

Mr. Linneen: Some seven or eight years ago I had a contract in a city in Michigan to lay about fourteen miles of pipe. It was all tested to three hundred pounds to the square inch, hammer tested; we had the affidavit of the superintendent of the works that manufactured it, as well as the statements of the men that we sent there to inspect it. We put it into the ground with a great deal of care and according to the wishes of the inspectors appointed to see that it was laid according to specifica-

tions, and it took me about four months before I could supply water to the city through that pipe. I succeeded in breaking it under various pressures of from twenty to seventy-five pounds, and finally got it to stand one hundred pounds; but I had to replace six miles of pipe.

Mr. Benzenburg: The only answer I can give, knowing what I do, is that the inspector had been dined and wined. I cannot possibly conceive how a pipe, when submitted to a test—hammer test—and three hundred pounds quiescent load, should give way under seventy-five pounds pressure in the trench. As to water hammer I think I will yield to some one else. To my mind there is no more myth about it than in seeing the gentlemen present at this convention. I have watched it and have made experiments with it, and I know we have had a water ram in our pipes time and again, and I don't think it is so uncertain a quantity but what it can be very nearly estimated. It is caused by the flow of water, by the velocity of water under pressure, being immediately stopped, when a rebound takes place, and the two currents coming together a pressure is exerted upon the pipe. I have seen the water hammer show its effect for a distance of a mile and three-quarters from the source. I have seen it a mile and a half throw down six standard hydrants in the twinkling of an eye. I have seen the water gauge jump from twenty pounds to three hundred and eighty, a mile and a quarter away from where the hammer was caused. I have seen it jump from twenty pounds near the source, or about a quarter of a mile from the source, where the water hammer was being caused, up to four hundred and eighty pounds and break the gauge. I have broken two or three gauges in that way, and it has been caused in every case where I have examined into it by the sudden shutting off, by the sudden stoppage of the velocity with which the water is flowing through the pipe and by its rebound. Now, the amount of the hammer or ram, to my mind, depends on the volume of water that is being stopped and the velocity with which that water was flowing. These are the two elements, and they will go to a large extent towards determining the amount of the water hammer. In different sized pipe, flowing under different velocity, a different force will be exerted, and it seems to me perfectly rea-

sonable that these are the elements by which you can nearly determine the amount of the water ram, the volume of water that is in motion, and the velocity with which it flows and the suddenness with which it stops. In the first instance that I spoke of, a railroad was drawing water and the engineer shut off the water as suddenly as he could. I found in two or three different cases where large manufactories used the drop valve and cut the water off almost instantly, that it broke meters and everything else in the neighborhood.

Mr. Tubbs: I want to tell you a story. I want to say first that I don't believe this convention can afford to fix a standard of weights or thickness of iron for water pipes. I want to say, second, that I don't believe you can afford to hold the manufacturer after certain tests have been made, after placing the pipe in the trench; there are so many conditions that must be considered; an improper laying of pipe, settling, and things of that sort, may affect the permanency of the pipe. I do think that the pick inspection that I have spoken of in connection with the 300 pounds water pressure is the best inspection you can make. I agree with Mr. Benzenburg about the possibility of determining about what the ram is going to be; simply the quantity of water, the velocity and the rapidity with which it is shut off—that determines it. I arose more to tell my story. I had an inspector that was sent to a foundry east, and they tried to dine him and they tried to wine him, and all that sort of thing, and he would not be wined or dined, and the result was that one of the owners of the foundry—I call no name, I don't know but there is a representative here that knows all the facts, but I state it because I am proud of it. One of the owners kept saying to him: "You go away from here. You had better not bother about this pick inspection and this other inspection; we will make this pipe satisfactory to your people." He says: "My business is here; I know no other business except to do exactly as Mr. Tubbs told me." And that man interfered with him so much he knocked him down, and the report came to me, and I said: "You did exactly right; you can knock every other man down around the factory that interferes with you." There are some such men as that.

Mr. Darling: I fully agree with this system of purchasing pipe, and that is to require the makers of pipe to guarantee it after it is laid in the ground. That I believe is one of the most practical tests you can get. Regarding the weight of pipe, the works which I represent have a variation of pressure from 65 pounds to 130 pounds. I am going to take the 6-inch pipe as an illustration. They adopted at first 35 pounds to the foot. When I came into the work, and after having received a little education in it, I satisfied myself that 30 pounds would stand our pressure just as well as 35 pounds, and I used that as a standard. I can say that since that time I have reduced that, and now buy 6-inch pipe as light as 26 pounds per foot. I can also state that at the connection of the Central Falls division we had some what we call force-pump pipe in the ground, where they formerly used the force-pump before the water works were introduced. We have there a main line of 6-inch pipe that was originally made for the force-pump, which weighs 22 pounds to the foot. We connected on to it as an experiment, to see whether it would stand the new pressure or not. If it didn't, they were going to take it up; if it did, they were going to leave it, and the practical result of that is that it remains to-day and is standing 95 pounds pressure. So that you see we have a practical illustration of anywhere from 22 to 35 pound pipe under the same pressure. I believe that the circumstances called for are best governed by those who have to put the pipe in the ground. I want to say one thing for the builders of pipe. I believe we have got honest men that are manufacturing pipe for us, not only in the east but in the west, or in the south, and when they tell you that they will test your pipe to 300 pounds hammer test, I believe that those men will do just what they say. There may be cases where, as the gentleman says he had some little experience, but I think those are few and far between. I never had an inspector at the foundry. If I do anything, I go to the foundry during the time that my pipe may be called for, and there myself see the pipe put under the pressure and the hammer put to it. That is the only inspector that I have ever sent to the works. I feel that we cannot adopt any system of weight here which would apply to every situation. I believe that every superintendent or every engineer of water works is the best adapted to know his own situation.

Mr. Linneen : Mr. Darling I would like to ask whether that pipe you referred to was cast iron pipe or not.

Mr. Darling : We use nothing but cast iron pipe.

Mr. Gardner : And use a twenty-two pound, six-inch pipe.

Mr. Darling : Yes sir, we had in the ground a mile of twenty-two pound, six inch pipe, that was originally put there for the force pumps, and we connected the rest of it onto it and it has been there for eleven years and we have never had a length burst.

Mr. Gardner : Have you connected with that pipe any quick moving valves ?

Mr. Darling : We have all those conditions on our work from one end to the other, on even that pipe.

Mr. Gardner : I am thoroughly impressed with the idea that we are using too heavy pipes, too much weight in our cast iron pipes. There is a margin to be allowed for that hydraulic ram. My friend, Mr. Linneen, says it is a myth ; there is no such thing. I am satisfied that there is such a thing and a provision ought to be made in the weight of the pipe for these conditions. You had a twenty-two pound, six-inch pipe which is the standard light weight.

Mr. Darling : I want to say, gentlemen, that I would not recommed twenty-two pound, six-inch pipe under the pressure we have, but there is the actual fact : there is the practical working of it. Now, I want to say just one thing more. I believe that we are using an excessive amount of iron. I believe it in my own case. I have seen since I left home six-inch water pipe that was anywhere from 440 to 468 pounds. My attention was called to the figures on the pipe ; six-inch pipe, twelve feet lengths, and yet that water company's pressure does not necessarily exceed forty pounds. Now, I want to ask any superintendent who has any practical experience in water works if he believes that it demands any such weight of pipe.

Mr. Tubbs : I want to impress upon this convention one thing ; I know that cast iron $\frac{1}{8}$ inch thick made pro-

perly will stand the ordinary pressure in water works as well as that half an inch thick. I speak understandingly. I refer to Brother Benzenburg and men that know that there is strength enough in the iron to sustain the ordinary pressure of water. I want to impress upon this convention the importance of improving a hydraulic test. Excuse me gentlemen, it is a fraud. It is a good thing in connection with other tests but it is a fraud on the face of it, but a pick inspection is better than all others.

MR. DARLING: I want to ask Mr. Tubbs if that pick would penetrate one-eighth of an inch pipe under any circumstances.

MR. TUBBS: If it is a quarter inch thick it won't: if it is an eighth of an inch it will.

MR. MILNE: I am very glad to hear such a controversy about cast iron pipe. I don't know as much now as I did an hour ago. There is a wide difference between theoretical engineering and practical engineering. And I think most men in this room will coincide with my views. I rather like the remarks of my friend, Mr. Tubbs. I think there is a great deal of merit in what is called a hammer test. A hammer test is capable of several constructions as applied to testing iron pipe. There is no engineer of any wide experience in this country but what will concede that it is essential for permanent construction in all water works that twice the pressure should be provided for in your pipes over your static head. The real practical hammer test is the pick test. It is the point of a hammer driven into the "bell end" and the "spigot end" of the pipe. There is no other effectual test. Any man familiar with the construction of iron pipe in its manufacture knows that the weak points are in the bell end and the spigot end of the pipe. In modern construction all iron pipe is cast with the bell end up, and if there are any deficiencies in casting, any deficiency in tempering the iron, it is found in the bell end of the pipe. Now, gentlemen, these are essential, vital points in construction, and the point of a hammer will determine the characteristic in the construction. The tensile strength of the pipe is determined by what is denominated the "bar" test. Every heat your inspec-

tor, assuming that he is an honest man, will have a portion of the iron cast in a mould about an inch and a quarter by twelve inches long, that will determine the charcteristics of your iron pipe. No inspector at the foundry is supposed to know his business unless he knows the tensile strength of iron and no tensile strength is determined except by the test of the bar of iron.

It is not necessary for me to prolong this controversy. These are some of the questions and circumstances that necessarily enter very largely into the case. This convention could not afford to adopt any standards which would govern any man, but each man must be governed by his own intelligence and his own experience. Mr. Darling says that perhaps we are using too much weight in iron pipe. I don't think so. I think it is well to have a liberal construction of the amount of iron you want in the pipe in case of emergency. The more weight you have in an iron pipe the longer it will last. That is the only safe construction, as an economic consideration. If you put light weight into the ground, no matter if it stands the test, the durability is determined by the thickness. The thicker the pipe, the longer it will last.

Mr. Owen: This question of determining the thickness of pipes reminds me of a meeting I attended in which the discussion of steel rails was held, and the problem there was that they could not get steel rails satisfactorily made on account of the engineers' determining the specifications which were practically impossible to fulfill. That is, the engineer had started to cut down the weight of the rails. The question pending here of trying to reduce the thickness of standard iron pipe seems to open up that very same problem. The manufacturers of cast iron pipe, as I understand it, on the basis of present practice have determined the certain metals and certain mixtures in pipe which they use for that purpose. If you, as an Association, should start and determine to reduce the normal thickness of all the pipes the mixtures and the modes of casting would have to be radically changed. You may be able to cast that quality of pipe but you have two serious difficulties to encounter. In the first place the quality of iron used has to be increased. The second question is the danger of handling thinner pipe. We all know what difficulty we have with

cast iron drain pipe which comes an eighth of an inch thick. We all know what extreme care has to be used in carting it around, and we all know that that pipe costs considerably more per pound than the ordinary water pipe, so I would suggest, on this question, that we start very slowly although there may be apparently a question of economy. I think it would be a dangerous precedent to adopt.

Mr. Darling: I don't stand here to advocate the reduction of the standard weights. If I understand it correctly the manufacturers of to-day recommend for heavy pressure anywhere from twenty-eight to thirty-six pounds to the running foot for six inch pipe. I take the medium and I say that thirty pounds for six-inch pipe ought to be considered heavy enough to carry anything that will be ordinarily called for. I am not here to say that I would reduce the weight of six-inch pipe down to twenty-two pounds per foot, simply because we have got a case that has proved that it will stand a ninety pounds pressure for ten years and yet be perfectly good. I don't wish to have the gentlemen understand that at all; but I don't think we need thirty-six pound six-inch pipe.

Mr. Cameron: I think the whole thing comes back to the circumstances surrounding the case. We have been very much enlightened, I have, but this discussion to-day comes right back to the original proposition whether the sense of this convention shall be that we shall have a certain standard in weight of pipe. As far as pipe manufacturers are concerned I agree with Mr. Darling that they are all honorable men. We have not had a pipe burst in a trench that the pipe manufacturer has not replaced at his cost. We have laid pipes for eighteen years in the city of Memphis and I have never had a pipe break but once after the pipes arrived at the place. We have never sent a man to test a pipe. We use the standard weight of pipe. This convention cannot adopt a standard any more than they can arbitrarily say that the pipes shall be laid two or four feet under the ground. We come right back to the very start that we cannot make it the sense of the convention to adopt a standard.

A MEMBER: Wouldn't it be best to have an outside measurement: Why not get a standard outside diameter?

MR. LINNEEN: There is a gentleman that has joined us to-day, an engineer of eminence, and he has a paper which I would like to hear read.

MR. TUBBS: I move we close the discussion and proceed to the next paper.

MR. RUSSELL: I have laid a good deal of pipe in my time and I don't consider that 300 pounds is any test at all, or rather a very mild test, for six inch pipe. I want to state something on this point and that is that this committee who made this report didn't undertake to impeach the experienced gentlemen of this convention, or to say what thickness they ought to have for their pipe. They simply classified the pipes within the range within which they are at present used. By making three classes we can almost cover the entire range of weights now in use. A man has a choice of three classes. You order thirty-three pound pipe, you may get thirty-five or thirty-one pound pipe. This committee simply proposed this classification which leaves the choice very much open to the consumers of the pipe, but enables the foundry to keep a stock of these goods.

MR. RICHARDS: Mr. Linneen does not think there is any such thing as a water hammer. I know of an instance where at a point about 150 feet from the engine house and about fourteen miles from the city; when a hydrant was shut in the city, the column of water in motion that was going from the works and the column that was being drawn back from the city, came together in a hollow, a collision occurred and blew out six feet of as nice pipe as you ever saw and that water pipe has been tested over and over again.

PRESIDENT: The Chair desires to state before going on with the discussion it that should be distinctly understood that the Associate members are entitled to the privilege of entering into all discussion.

MR. CAMERON: Mr. Yardley has a paper on this subject and I would like to hear it. Mr. Yardley is an old

pipe manufacturer and understands all about it. I make a motion that Mr. Yardley be requested to read the paper.

Motion carried.

SPECIFICATIONS FOR CAST IRON COATED WATER PIPE.

BY THOMAS W. YARDLEY, CHICAGO, ILL.

In many years experience as a maker and purchaser of cast iron coated pipe, I have never met with any standard form of specifications for such. Each water works company employing a hydraulic engineer, has under his direction prepared complete specifications for the particular conditions required; but I cannot find that any two are alike; and each foundry in bidding for the the supply of such pipe, makes the price to cover the conditions required. I therefore have the honor of offering a form of specifications for cast iron coated water pipe that will be found useful to water works companies, and others requiring pipe of this kind. The conditions are all reasonable, and can be carried out by makers without additional cost, and with advantage to purchaser.

Section 1, gives the kind of pipe, with its general characteristics.

Section 2, specifies that neutral pig iron shall be used, since such iron possesses the strength required, and is uniform in shrinkage.

Section 5, requiring makers to give the brands of pig iron used in the cupola, is intended to guard against the use of cinder-iron. The characteristics of the ores used in blast furnaces give to each its reputation; and the furnaces using cinder are all well known.

Section 7, providing that the shell of each pipe shall be measured for thickness throughout its entire length, enables the inspector to determine whether there are thin places near the middle of the pipe, where such imperfections are most likely to occur. An inexpensive instrument, adapted to such measurement, has been devised.

Section 8, provides for a test-bar, from which to determine the transverse strength of the iron. This bar is convenient in form, can be made with very little cost to the maker, and will give the most satisfactory test of the strength of the iron under the conditions to which the pipe will be subjected in service.

Section 11, requiring that all pipe shall be stripped immediately, if taken from the pit before cooling, is very important, for the reason that when pipe are taken from the pit hot, a deposit of loam is frequently left in spots on the outside; and wherever this occurs, the cooling is irregular, and the shrinking strains are unequal. The weakness thus produced may not show under the subsequent hydraulic test, but may be developed after the pipe has been subjected to rough treatment in railroad and other transportation into the trenches.

SPECIFICATIONS FOR CAST IRON COATED WATER PIPE.

Section 1.—The pipe shall be of the usual kind known as "Hub and Spigot;" each pipe shall be twelve (12) feet in length from the bottom of the hub to the end of the spigot; the form and dimensions of hub and spigot-ends shall be as marked on and shown by drawings, to be furnished or approved by purchaser.

Section 2.—The metal shall be of the best quality for the purpose, made from what is commercially known as "Neutral" pig iron, which shall have been made from iron ores without the admixture of cinder, and when cast into pipe the metal shall be tough, and of such density and texture as will permit its being easily cut and drilled by hand.

Section 3.—Each pipe shall have cast on the exterior surface of hub in raised Roman letters, one and one-half (1½) inches long, and shall be further marked in like manner with letters and figures to designate the maker of the pipe, and the year; also serial numbers shall be cast on each pipe, commencing with a number to be designated by the purchaser.

Section 4.—The pipe shall be cast in dry sand moulds, or flasks, placed vertically, and shall be of the several diameters named in the contract. The shell shall be of uniform thickness of metal, smooth and sound, without cold-shuts, lumps, swells, scales, blisters, sand-holes, or other imperfections; truly cylindrical; of full diameters; and with interior and exterior surfaces concentric.

Section 5.—Chemical analyses of the iron used shall be given whenever asked for; and a written daily report shall be furnished to the Inspector, giving the brands of pig iron used in each day's melting.

Section 6.—Each ladle of iron from which the pipes are poured shall be designated by consecutive number, beginning with each day's work. A daily record of pipes cast shall be kept and furnished to the Inspector, and must record the number of the ladle from which each pipe was poured, as well as the number on the pipe.

Section 7.—The shell shall be of uniform thickness throughout its entire length. Should the Inspector find in any one place a variation in thickness of more than ten (10) per cent. less than that specified in the contract, such pipe shall be rejected.

Section 8.—From each ladle of melted iron there shall be cast one test-bar, not less than (26) inches long, two (2) inches wide, and one (1) inch thick. This bar shall be tested for transverse strength when loaded in the centre, twenty-four (24) inches between supports (narrow sides vertical), and shall carry a center breaking load of not less than two thousand (2,000) pounds per square inch, and showing a deflection of not less than 3-10 inches before breaking. This bar shall be cast as near as possible to the specified dimensions without finishing up but correction shall be made for variation of width and thickness ; and the corrected result must conform to the above requirements.

Section 9.—If any test-bar shows a breaking-strain or deflection less than the above requirements, all pipe made from the corresponding iron shall be rejected.

Section 10.—The maker shall furnish to the Inspector in charge two wrought iron rings (male and female templates), the one showing the outside diameter of the spigot-end, and the other the inside diameter of the hub-end of each size of pipe ; and the said pipe shall conform in diameters to the respective templates.

Section 11.—The pipe shall be thoroughly cleaned, both inside aud outside, without the use of acid or other liquid. If the pipe is stripped while above a dark blue heat, all sand must be removed from the outside immediately.

Section 12.—When the pipé is so cleaned, it shall be heated to 300 degrees Fahrenheit, and immersed in a bath of coal-pitch varnish of an equal temperature. When the pipe is removed from the bath this coat-

ing shall *fume freely*, and set perfectly hard within one hour from the time of removal. No pipe shall be tested by hydrostatic pressure until the varnish has become hard.

Section 13.—When coated, the pipe shall be subjected to a test by hydrostatic pressure of not less than four hundred fifty (450) pounds per square inch for 6-inch and 8-inch ; four hundred (400) pounds for 10-inch and 12-inch ; three hundred and fifty (350) pounds for 16-inch and 20-inch ; three hundred (300) pounds for 24-inch and 30-inch ; and two hundred and fifty (250) pounds for all 36-inch diameter and upwards; and while under such pressure the pipe shall be subjected to an additional test by a series of smart blows at various points throughout its entire length with a three (3) pound hammer, attached to a handle sixteen (16) inches long. If any failure is shown in the pipe during this test, it shall be rejected.

Section 14. The weight of each pipe must correspond as nearly as possible to the standard named. Any pipe which may fall short over five (5) per cent. of the standard weight shall be rejected, and no weight shall be allowed or paid for on any pipe that shall exceed two (2) per cent. of the standard weight. These requirements shall be determined by the weight of each pipe separately.

Section 15. All special castings, such as "Ell's," "Tee's" "Y's," bends, crosses, etc., shall be made from the same mixture of pig-iron as has been approved for pipe; and all such casting shall be submitted to the same care in cleaning and heating, and the bath shall be used under the same conditions as for straight pipe.

Section 16.—All appliances necessary for the Inspector to carry out the requirements of these Specifications shall be furnished by the maker, free of cost to the purchaser.

Mr. Tubbs : I move that a committee of this Association be appointed to get up a series of specifications for cast iron pipe, of which the reader of this paper shall be the chairman, to report at the next meeting. There are very many points in this paper which I think should be considered.

The President : That motion is hardly in order.

Mr. Cameron : I move that Mr. Yardley be thanked and that the paper be spread on the record, as a part of this discussion.

Motion carried.

Mayor Haynes of New Jersey : Mr. President and Gentlemen—You have a large number of practical men here and you all have your own ideas. I am personally interested in this matter as the city of Newark has a contract for a new supply of water that is to be brought a large number of miles, 25 or more. The question is what is the best material for that pipe. Whether it

shall be of wrought iron or steel or the regular cast iron pipe; whether a pipe made of steel say 5-16 of an inch is better than cast iron of the ordinary construction is the question that I would like to have answered individually and in this manner.

THE PRESIDENT: This question is not germane to the subject now before the House, and if Mayor Haynes will just defer it until we dispose of that we will then take it up.

A motion was made that the report of the committee making a standard for cast iron pipe be disagreed with for the reason that the Convention is not prepared to do anything of that sort.

Motion seconded.

MR. OWEN: I don't think it wise to stop the investigation of this question at this time. If the Association are not prepared to take any action in the matter, I will move as an amendment that the report be referred back to the committee and the committee continued.

Amendment seconded.

MR. RUSSELL: I want to say that I think nothing can be accomplished by continuing that committee and for myself I have hardly the time to give to it. If the work is to be continued I would suggest the appointment of a new committee or at least put new members into the committee so as to shed new light on the subject.

THE PRESIDENT: I am of the opinion that possibly the members don't understand the question. I don't think this committee in submitting this report desired to submit an arbitrary standard. It was simply a standard by which unexperienced men could get an idea to draw their specifications from.

Motion carried.

MR. TUBBS: If I am in order now I put my original motion, that is, that a committee be appointed of this Association, of which the gentleman who read the paper just now, shall be the Chairman, to report at the next convention specifications for cast iron pipe for the consideration of the convention.

Motion seconded.

Mr. Armstrong: I seconded that motion for an opportunity to discuss it. I don't think this association ought to make an arbitrary specification whereby the members shall be compelled to make their specifications in accordance therewith. I believe each and every man in this association is learning every day that he lives. What is in a specification to-day he may cast aside to-morrow. I think this is wrong. I don't want the pipe men or any man in business to dictate to this association or the members of this association what their specifications shall be.

Mr. Nichols: I would like to know where we young men are going to find out about all these different things. It seems almost every city has different circumstances under which the pipe is subjected. If the pipe is carefully laid it seems to me that chemical action has a great deal to do with the life of the pipe. It seems to me we ought to at least listen to the experience of others and draw from that: not each one go blindly ahead doing just what he thinks is right.

Mr. Cameron: It seems to me we can simplify this by having it understood that this committee's report will be a sort of a guide. It is not incumbent upon us to follow it.

Mr. Armstrong: Experience is the great teacher of all things. Each and every locality is a law unto itself. The conditions of one locality are not the conditions of another locality, consequently observation must be the guide for these things. A pipe that may last five years in one locality may last 50 years in another. I know that from my own experience of 30 years in connection with water works either directly or indirectly. Now, if any gentleman here, this afternoon, can lay down a formula to me for the construction of the material that enters into a pipe, I am willing to listen to him. What has been the experience of engineers all over the world. Last year I removed over 22 miles of pipe because that pipe was filled up with sediment. That pipe according to the talk of some gentlemen here ought to last for 100 years. The question is this: not whether it is cast iron or whether it is wrought iron pipe or whether one material enters into the construction of

a pipe or another, but what is the best material to enter into the construction of a pipe for the necessary durability.

THE PRESIDENT: The motion before the house is upon the appointment of a committee, of which Mr. Yardley shall be chairman.

Motion carried.

PRESIDENT: Mayor Haynes has asked a question, and it will be left with the Association whether we will bring up that discussion now or go on with the original papers.

MR. HAYNES: I am not an engineer, but am in pursuit of knowledge. I have come nearly 1,000 miles to obtain it. If I can get an answer to my question, I will think I have not come this distance in vain.

MR. OWENS: I will state that probably one or two points are requisite for you to understand the subject. The contract provides for water to the amount of fifty million gallons per day to be brought down from the mountains to the city of Newark, a distance from the main reservoir of about 24 miles. The source, I think, is about 600 feet above tidewater. The highest delivery in the city of Newark will be about 300 feet.

PRESIDENT: The question propounded by Mayor Haynes is perfectly proper, and it is the hope of the Chair that any members who feel competent to give an opinion on the question, will do it. That is one of the objects of this Association, that we shall help each other in these very knotty questions.

MR. ARMSTRONG: I am here for information. I have got at the present time quite a contract to be developed. The city which I represent is now taking into consideration plans involving the expenditure of probably two millions of dollars. The question with me is whether wrought iron or cast iron are the most available material, or most economical material; which will last the longest time and give the best results in the end. I would like the matter discussed. The question in my mind is whether it is better to hold on to the old iron, the cast iron, pipe or fall back on the wrought iron or steel pipe.

The difference of cost between the two pipes amounts probably to $300,000.

MR. HOLDEN: I see that Mr. Armstrong has not answered the Mayor's question. It seems to me that in a contract involving two millions of dollars the question of durability should be taken into consideration fully as much as anything else. I know something about the durability of cast iron pipe. I have got some that has been laid forty years, and I think it is good for forty years more. I never found any wrought iron that would last half that length of time. Steel is something comparatively new. My advice to the Mayor would be to take something that will be durable. As I understand it, the company will lay these pipes and after eleven years the city take them. At that time, of course, the city want them in good condition. I don't know of any one who has had a long experience with steel, so as to know how long it will last.

MR. RYLE: I don't see how we can answer this question understandingly. We have no specifications; we don't know how far apart the expansion joints on the line are to be; how deep it is to be laid in the ground. I think it would be best to lay this question on the table.

MR. ARMSTRONG: I will give the gentleman information that the pipe will be 60 inches in diameter; expansion and contraction will be provided for and it will be laid in the ground.

A motion made that the matter be laid upon the table.

Motion seconded.

PRESIDENT: The Chair would suggest to Mayor Haynes thathe submit the matter rather in the form of a question written out and put in the question box. I think it would be more satisfactory to him and to all the members.

MR. MILNE: I don't think there is any member of this Association that is familiar with the question of steel pipe, consequently no intelligent discussion can be had on the subject. I know no one this side of the Pacific slope that knows anything about the use of steel

pipe for water mains. I would second the motion that the matter be laid on the table.

MR. HAYNES: I am aware that if it is laid upon the table that that will be the end of it. I simply wish an expression of this Association.

THE SECRETARY: I move that the President do as Mr. Haynes suggested; ask those who favor steel to signify it, and those who favor wrought iron and those who favor cast iron to signify it. I offer that as an amendment.

Amendment seconded.

Motion to lay the matter on the table lost.

MR. TUBBS: I move that this matter be left until Thursday, long enough for the members of this convention to think about it.

MR. DONAHUE: I think it is only just and honest that a man in expressing his opinion should do it with honesty, and that a man who has had no experience with cast iron should not vote against cast iron, etc. I think that the vote should be confined to those who have had absolute experience with steel, or with cast iron, or with wrought iron. I don't think this Association ought to express itself on a subject with which it is not familiar.

THE SECRETARY: I understand that all Mayor Haynes wants is an expression of the individual members. I don't understand this is to go on the minutes of the meeting at all.

MR. BENZENBURG: I understand that this question is under consideration by an eminent engineer, who is now on his way from the Pacific coast, and it seems to me that any expressions we give here may perhaps prejudice him, and I would rather, for my part, that the Association or the members give no expression in the matter. It is something that may lead into further trouble hereafter, and the Association having nothing to do with the matter as an association, it seems to me better not to give an expression in this matter.

MR. HORNER: There seems to be great hesitancy on the part of our members. I think it is largely due to the fact that they are afraid they may make an error. It is

a vital question and the judgment of this Association will largely influence our brother, and as perhaps very few of us are familiar with the conditions we had better not make an expression.

MR. TUBBS: I know more about this than most of you I tell Mayor Haynes now that it will cost something to get my positive opinion.

Motion to grant Mayor Haynes' request lost.

THE PRESIDENT: The next in order is a paper by Mr. C. N. Priddy, of Leadville, Colo.

ON THE LAYING AND MAINTAINANCE OF MAINS, HYDRANTS AND SERVICE PIPES WHERE FROST GOES DEEPER THAN THEY ARE LAID.

Ours are laid six feet deep and the frost goes seven feet deep. After laying and before filling in with dirt we pack around with good stable manure which makes a good warm dirt even after the life is out of the manure. All large rocks and boulders should be removed and not put back in the ditch. Hydrants should be boxed around the bottom with two inch lumber two by two and a half feet and two feet high without bottom, a one-half inch pipe carrying from same up by the side of hydrant to blow steam in. All services laid in double boxes, the double boxing makes an air chamber preventing frost from catching the pipes so quick. One box eight inches in the clear, the other four inches, and the pipe laid in that with a one-half inch pipe carrying up by the side of the curb box, and also extending a ways in the box each way to blow steam in. We have a steam boiler, about four horse power, mounted on a wagon which we hitch horses to. We open the hydrants most every day after the frost gets down, and if they are beginning to catch or freeze, with a little experience most any one can tell, we blow steam down the one-half inch pipe to warm up the bottom of the hydrant, if the four inch leading to the hydrant is froze. We take the top off and take the inside barrel out and have a heavy one-half inch steam hose which we feed through a two inch pipe, bent a little at the lower end, and it is very easy to feed it through to the main pipe, cutting out all the ice in a few minutes. If the main pipe freezes we dig down as soon as possible, drill a one and one-fourth inch hole in the main and feed in the steam hose either way, of course it is necessary to shut off the water, therefore should have plenty of valves. If taken in time we seldom have a pipe burst. And for service pipes if we are notified as soon as they freeze, we attach our steam hose on to the one-half inch pipe or stop box and blow steam for a few minutes into the double boxing and it thaws it out. We seldom have a bursted pipe if taken in time. We do not agree to keep service pipes open, but as a rule when we are steamed up and have the time we make no charge for thawing them out. Our plumbers have similar steamers only on a smaller scale to pull by hand, which they use quite extensively, and for which they charge the consumer. We

also have a system of changing valves and opening hydrants to test the different cross streets, by which we can tell if the main pipes are freezing. If so we let the hydrant run for a few minutes and the water will cut the ice out. The temperature of our water is from thirty-three to thirty-five, and where it is possible when pumping we turn the exhaust into the pump to raise the temperature, which is quite a benefit.

Respectfully,

May 20th, 1890. C. N. PRIDDY.

MR ARMSTRONG: I think that the paper is worthy of discussion for the reason that in many sections of the country frost goes very deeply into the ground. I think the matter ought to be discussed for the reason that engineers in connection with water works ought to understand all these conditions.

THE PRESIDENT: If there is no discussion on Mr. Priddy's paper we will proceed to the next paper on the list.

The Secretary read the paper by Mr. LeConte on "Contamination of storage water on the Pacific Coast and the palliatives resorted to.

CONTAMINATION OF WATERS IN CERTAIN STORAGE RESERVOIRS ON THE PACIFIC COAST, AND THE PALLIATIVES RESORTED TO.

BY L. J. LE CONTE, M. AM. W. W. ASSOCIATION.

The annual contamination of municipal water supplies, depending solely upon the catchment and storage of surface waters, is a subject which naturally attracts more and more attention each year.

The experience gained on the Pacific coast during the past twenty-five years is particularly instructive from an engineering point of view in that the physical conditions, which tend to bring about deleterious changes in the quality of the ponded waters, are presented in their most exaggerated form. For this reason more than others the progressive changes, which take place from time to time, are naturally much more pronounced, and therefore, more easily observed and studied. In order to be as brief as possible, consistent with clearness, I will confine my attention to the water supplies of San Francisco and Oakland, since they are truly characteristic.

In the first place, as to the climatic conditions. A very marked difference exists between the climate of the Pacific coast and that of the Atlantic slope in regard to the rainy season. In the former, the rain each year is usually delivered between November and May, soon after which time the streams generally become dry. The most favorable years give no water supply for half or nearly half the year, while a dry year gives no supply whatever, so that it may happen that no surface waters enter the storage reservoirs from March or April of one year to November or

December of the next year, an interval of 600 days. The case may be even more unfavorable, due to a succession of three or four winters of small rainfall.

The engineer should not feel safe unless he has storage capacity for 900 days' supply. This fact compels the construction of very much larger storage reservoirs than would be necessary in other countries, in order to make allowance for the extreme features of the climate. As a final result, the works have to be planned so as to practically catch all the storm waters, and nothing is allowed to run to waste.

As to the quality of the water. Here again the natural difficulties are still further aggravated by the dry season occurring during the summer months, when the weather is very warm. This fact leads to extraordinary deterioration in the quality of the ponded waters, more particularly when the water level in the reservoirs gets to be very low. The regular cycle of changes through which they pass, year after year, is of great interest to the engineer, and is full of instruction.

I will next give a brief description of the water supplies being considered.

SAN FRANCISCO WATER SUPPLY.

The city of San Francisco derives its chief supply of water from three large artificial storage reservoirs, located in the Coast Range of mountains, and are known as the "Pilarcitos," "San Andreas" and "Crystal Springs."

PILARCITOS RESERVOIR.

This supplies the high service system, and was built in 1864. Its capacity is 1,080,000,000 gallons above the dead water line. Area of water surface 115 acres; elevation 696 feet above high tide. Dam is earthwork, 95 feet high by 650 feet long. Depth of water at dam, when full, eighty-five feet. Direct water shed six square miles, and is all mountainous. Average annual rainfall fifty inches. This reservoir is connected with the city by an aqueduct consisting of three tunnels, lined with brick and cement, having an aggregate length of 7,870 feet; also 8,300 feet of wooden flume and 69,336 feet of thirty inch wrought iron pipe. This brings the water to Laguna Honda service reservoir, capacity 33,000,000 gallons at an elevation of 377 feet above high tide. Just before entering the reservoir, the water passes into the screen-house, where it is made to strain through a system of cloth screens, which will be explained in detail further on. The screened water passes from the screen-house into the service reservoir above mentioned. From here a twenty-two inch pipe delivers the water to the highest part of the city in the Western Addition.

SAN ANDREAS RESERVOIR.

This supplies the middle service system, and was built in 1867. Its capacity 6,690,000,000 gallons above the dead water line. Area of water surface 525 acres. Elevation 450 feet above high tide. Direct water-shed 4.1 square miles, and indirect water-shed drained by feeders, three square miles, and is all mountainous. Annual rainfall forty inches. Dam is earthwork, ninety-three feet high by 640 feet long. Depth of water near dam, when full, eighty-nine feet. This reservoir is connected with the city by an aqueduct consisting of 3,070 feet of tunnel lined with brick and cement, and 64,000 feet of thirty inch wrought iron pipe

leading into College Hill service reservoir, which is 253 feet above high tide, and has a capacity of 14,000,000 gallons. This reservoir also has a screen-house and system of cloth screens similar to that at Laguna Honda, and the water from the storage reservoir is always screened just before its entry into the service reservoir. The San Andreas reservoir holds all drainage waters, and nothing goes to waste in the wet season. It never has been filled but once. The Pilarcitos and San Andreas conjointly, deliver to the city an average of 9,000,000 gallons per day, derived from twelve and one-half to thirteen square miles of drainage area.

CRYSTAL SPRINGS RESERVOIR.

This supplies the low service system, and was built in 1877. Its capacity is 3,830,000,000 gallons above the dead water line. Annual rainfall, thirty inches. The water surface, 500 acres. Elevation 268 feet above high tide. Direct water-shed, 15 square miles, and is mountainous. Dam is earthwork, fifty feet high by 340 feet long. Depth of water at dam, when full, forty-six feet. This reservoir is connected with the city by an aqueduct consisting of 8,000 feet of wooden flume; 9,000 feet of tunnel and 16.92 miles of forty-four inch wrought iron pipe. This brings the water to the University Mound service reservoir, having an elevation above high tide of 169 feet. Here again the water passes to the screen-house, where it is made to strain through cloth screens before entering the service reservoir. The Crystal Springs reservoir catches all the storm waters, and nothing is allowed to run waste. The aqueduct supplies on an average, 22,000,000 gallons per day.

OAKLAND WATER SUPPLY.

The City of Oakland derives its water supply from two storage reservoirs constructed on the adjoining foot-hills and known as the San Leandro Reservoir and the Temescal Reservoir. The latter is quite insignificant, and the chief supply is taken from the former, which we will now describe.

SAN LEANDRO RESERVOIR.

This reservoir was built in 1875. Its capacity, 4,300,000,000 gallons above the dead water line. The water surface, 410 acres, and has an elevation of 225 feet above high tide. The water shed, forty square miles, and is mountainous. The dam is earth-work and 100 feet high by 450 feet long. Depth of water at dam, when full, ninety feet. The water on leaving the lake passes through the ordinary fish screen and then enters a double line of twenty-four-inch wrought iron pipe, but flows only a short distance before reaching the screen-house, where the water is made to pass through cloth screens, to be described further on. The screened water falls into a clean water basin. There are two of these basins, 800,000 and 2,000,000 gallons respectively. They are not covered. The water leaves these basins to enter into a large thirty-seven-and-a-half inch supply main leading to the City of Oakland, a distance of nine to ten miles. On arriving in the city the water is delivered to consumers direct, no local service reservoirs being employed.

The above gives a fair idea of the main features connected with these several reservoirs. It is well to mention that all of them are more or less stocked with fish, principally California and Eastern trout, also black bass, catfish, carp and white fish from Lake Michigan.

GENERAL HISTORY OF THE ANNUAL TROUBLES AFFECTING THE QUALITY OF THE POND WATERS.

The writer has devoted much attention to this subject during the past five years and has made many experimental observations and tests. I shall only mention those which have been carefully verified. I will begin my statement of facts in regard to the cycle of changes, which takes place year after year, by commencing in the winter, thence to the Spring, Summer and finally to Winter again.

TROUBLES IN THE RESERVOIRS.

Ordinarily in the Winter and Spring months, which is also the wet season, the quality of the water in the storage reservoirs is comparatively good, the temperature averaging, surface water forty-eight degrees and bottom fifty degrees Fahrenheit, the only objectionable feature being periodical turbidity due to fine loamy sediment, which is brought in by tributary streams. As soon as the stormy weather is over, the water rapidly becomes clarified by natural subsidence, the time required to complete this operation being generally two to three weeks. In case of the San Francisco water supply, this difficulty is obviated by shifting the supply to some other source less affected. In the case of Oakland, this is not practicable, since both the reservoirs are equally turbid about the same time, and as a result the muddy waters go into the pipe system and direct to consumers.

THE FERMENTATION STAGE.

As the season advances, the rains cease and the streams run dry. About the 1st of May of each year, the surface waters in the reservoirs have acquired a temperature of sixty-two degrees Fahrenheit, and the bottom water, say, fifty degrees Fahrenheit; all vertical circulation has stopped and the period of stagnation begins. Water fleas and some vegetable matter, mostly phænogamous plants, begin to show themselves to a limited extent in shallow water along the margin of the reservoirs, but not in sufficient quantity to amount to anything. As time progresses, and the waters get warmer, the next change observed is a chemical one, that is to say, bubbles of carbonic acid gas and light carburetted hydrogen rise up from the bottom to the surface, the temperature of the bottom water gradually rises, and in course of time attains the same temperature as the surface, say, sixty-five degrees Fahrenheit.

It will be as well perhaps to mention here, that the true cause of this change has been traced conclusively to the fermentation of the immense deposits of mud covering the entire bottom of these reservoirs, averaging ten feet in depth. This bed of mud, of course, has been many years in accumulating. Repeated examinations show that it is composed of animal and vegetable matter in all stages of decomposition.

THE TRUE CAUSE OF RANK VEGETABLE GROWTHS.

Now then, as a result of this fermentation, the waters of the reservoirs become highly charged with carbonic acid gas, and are robbed of free oxygen as well. Now what do we observe to be the next characteristic feature? Just precisely what might be expected; namely, a sudden and wonderful development of vegetable life, followed almost simultaneously by an equally wonderful development of animal life, principal-

ly in the form of water fleas. This vegetable life seems to belong mostly to the variety of cryptogamous plants known as algæ. Later on when they reach maturity they break up and develop millions upon millions of tiny green spores, which eventually permeate the whole mass of the ponded waters, imparting to them a beautiful green hue. When these conditions obtain, the spores become a source of great annoyance. They readily pass through the screening apparatus and enter the pipe system in which they die and decompose, thus injuring the quality of the water delivered to consumers. It is well, perhaps, to mention here, that these two items of contamination, vegetable and animal life, at first do no harm whatever to the quality of the water, while they are healthy; on the contrary, their presence in such prodigious quantities is nothing more than nature's endless effort to purify water, *which has been previously injured in quality*, and, furthermore, they would most certainly continue to perform this useful function in nature, but for the advent of the next stage in contamination—we will call it the "Fatal Stage"—and which is most disastrous in its results by giving rise to pernicious conditions, which lead to their death and subsequent decay, all of which is utterly ruinous to the qaulity of the ponded waters. The main characteristic feature of the fermentation stage above mentioned, is the fact that the gases developed give rise to no offensive odors of any kind.

THE FATAL STAGE, OR PUTREFACTIVE STAGE.

The next change noted in the reservoir is also a chemical one; namely, the fermentation of the bottom mud increases in activity, and in course of time becomes converted into putrefactive fermentation. This stage is at once detected by the change in the quality of the evolved gases rising from the bottom, which now become very offensive. Examination shows them to be carburetted hydrogen, carbonic acid, sulpuretted hydrogen. By this process the water in the reservoir soon becomes robbed of nearly all its free oxygen, as instanced by the fish at all times swimming at and near the surface, and becoming very languid in their movements.

During the first portion of this putrefactive stage, it was observed that the algæ and animal life were both doing their utmost to purify the water, but as this stage advances the fatal by-products of putrefaction, certainly sulphuretted hydrogen, and possibly septic poisons, begin to gain the upper hand, and finally the conditions become so bad that they give up the battle, break up and die and decay in large quantities.

This melancholy condition is called to your attention by masses of dead algæ forming great reddish brown blotches here and there on the water surface, mostly where the gases bubble up in abundance. These blotches soon sink to the bottom, thus adding new fuel to the putrefying matter in the bed of the reservoir. The above lamentable state of affairs *exists* to a greater or less degree during the months of August, September and October of each year, when the water is at the low stage, and at such times the quality of the water in the storage reservoirs is something almost incredible.

As the season advances, the first change for the better is noticed about the last of October or first of November, when frosty nights set in, and the surface waters become chilled and sink to the bottom, thus giving rise to vertical circulation, which cools the entire body of water, and

thus gradually checks putrefactive fermentation, and as a result the offensive odors are greatly reduced.

Chemical analysis made at the beginning of this vertical circulation show that the quality of the water is actually worse than at any other time during the year. This fact is undoubtedly due to the filthy bottom waters coming up and mixing with the surface water, thus spoiling the supply to consumers, which, you may say, is always taken from at or near the surface.

But no decided relief from bad water is experienced until the rainfall begins, generally in November, when the reservoir becomes filled up again with a fresh supply of cool surface waters, and the temperature is reduced to 55 Fahr. This fresh supply of rain water is always turbid. There are one or two very important facts connected with these storage reservoirs, upon which I should lay great stress, namely, the San Francisco and Oakland storage reservoirs are equally bad as to quality in midsummer. On the contrary there exists a very marked difference in the quality of the water as delivered to consumers in the two cities, and this important fact seems to be due unquestionably to the treatment which the water undergoes after it leaves the lakes. This naturally leads us to the next subject.

TROUBLES IN THE PIPE SYSTEM.

A careful study has been made of the quality of the water as delivered to consumers.

First—The San Francisco supply is derived from six different sources, all told, and consequently when the waters in any given storage reservoir become too turbid for use, they are enabled to shift the supply from one source to another, less affected, and thus to a large extent avoid delivering muddy water to consumers.

As soon as the rains cease, the water in the reservoirs clarifies rapidly, and in the course of three or four weeks becomes quite clear, and is very good in quality. About the 1st of June, however, offensive odors begin to develop in the supply to consumers in San Francisco, but nothing comparable to that experienced by consumers in Oakland. A careful examination made along the conduits from the reservoirs to San Francisco established conclusively an important fact, namely, that while the waters in the storage reservoirs were very bad, fully as bad as the waters in the Oakland storage reservoirs, yet as we advanced along the conduits it was observed that at all the open flumes and aqueduct tunnels, where the flow of the water was exposed to the air, the quality of the water continued to improve progressively, until finally when it reached the vicinity of the service reservoirs, within the city limits, *the quality was at all times very much better than the surface waters in the storage reservoirs, whence it came*, and consequently incomparably better in quality than the water delivered in Oakland.

The experience in Oakland is quite different, and deserves careful consideration.

OAKLAND WATER SUPPLY.

Second—During the winter and spring months the surface water in the reservoirs is allowed to run directly into the supply pipes, sedimentary matters due to storm waters included. As a natural result, more or less sedimentary matter is deposite in the pipe system, and quite extensively in all the dead-ends and

fire hydrant branches, in fact everywhere that circulation is poor or bad. During winter storms much of the finer loamy sediment finds its way to the faucets, and gives rise to universal complaint. As soon as the rainy season is ended, however, the water improves rapidly, and for a certain period in the spring is clear and really very good.

The supply continues to be reasonably good until about the middle of May, when disagreeable odors begin to develop, and especially when water is drawn from the hot water faucets the odors are excessively offensive. A very important fact should be noticed here, that this offensive stage in the pipe system *precedes* by one month the same period in the reservoir, and furthermore the most commonplace kind of test, as well as chemical analysis, show conclusively that during the entire putrefactive stage in the reservoirs, *the water in the pipes supplied to consumers in Oakland is always very much worse than the surface water in the reservoirs, whence it came.*

Direct examination shows that the true explanation of this fact may be traced to the deposit of filthy mud in the pipes, which is undergoing putrefaction (similar to that which subsequently takes place in the reservoir on a grand scale), but under infinitely worse conditions, from the fact that it is confined in the pipe system and excluded from contact with the air.

About the middle of June putrefaction begins in the reservoir, and as a result a fresh supply of decaying remains of vegetable and animal matters enter the supply main, thus adding new fuel to the fire and increasing the evil.

Experiments show that these two sources of contamination are sometimes so active and potent that the temperature of the entire water supply to Oakland is affected thereby. About the 1st of September, 1889, the Water Company began putting in new cloth screens, six thicknesses being used instead of two, as heretofore. A close watch was kept on the temperature of the water in the street mains, and in less than four days following their introduction, the temperature of the entire water supply, some five million gallons per diem, had dropped from 72° Fahr. to 68° Fahr., and then continued at the latter temperature for the remainder of the month.

An examination of the mud in the pipes shows what might be expected, that it is of the same composition as the bottom mud in the reservoir, and also that during the putrefactive stage is very offensive, and contains active red worms.

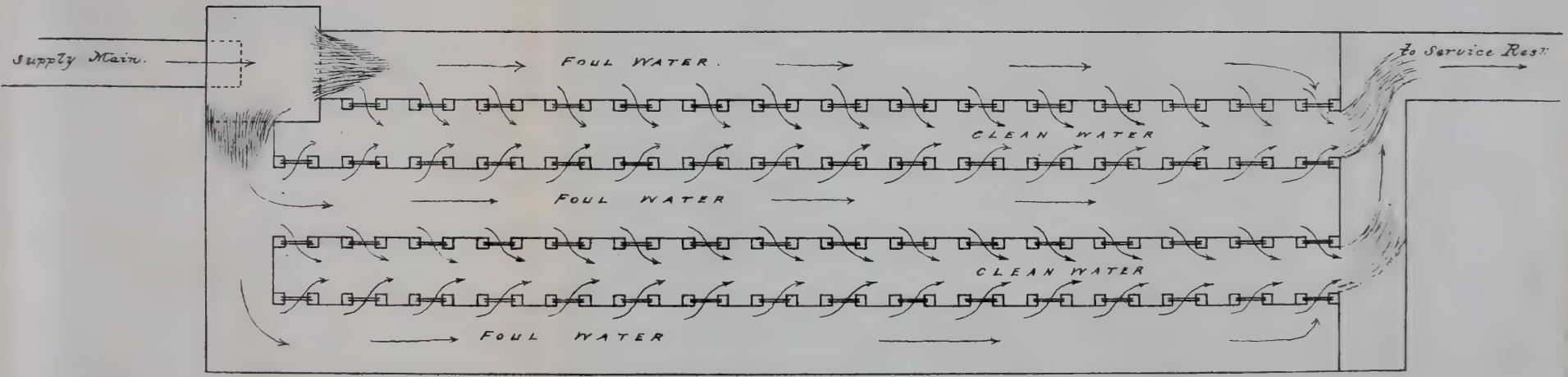
PALLIATIVES RESORTED TO.

Any one might naturally think after reading the above, that sand-filtration would be the proper remedy to apply in order to improve the water during the summer months. A little reflection will show that the physical conditions are such as to render it impracticable. That is to say, the quantity of vegetable and animal matter in the water in mid-summer is so great in amount, that it would clog a filter bed completely in a very short time, and it would consequently cease to work until cleaned. Hence it is interesting to know what is practicable under existing circumstances.

SAN FRANCISCO WATER SUPPLY.

Nothing is done at the storage reservoirs to improve the quality of the water before entering the conduits. The water first passes the fish

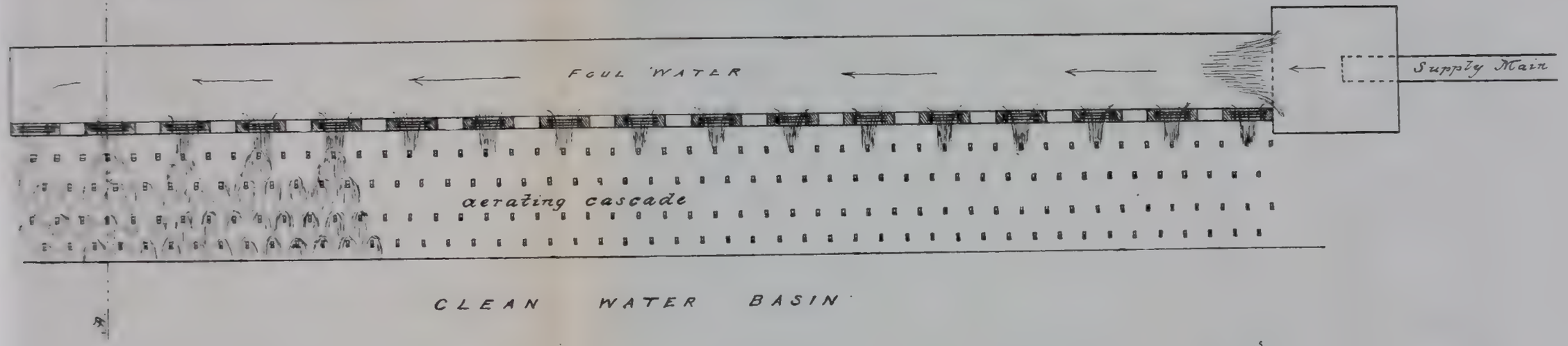
Sketch of wooden "Screen-Tanks" in use at San Francisco Cal.

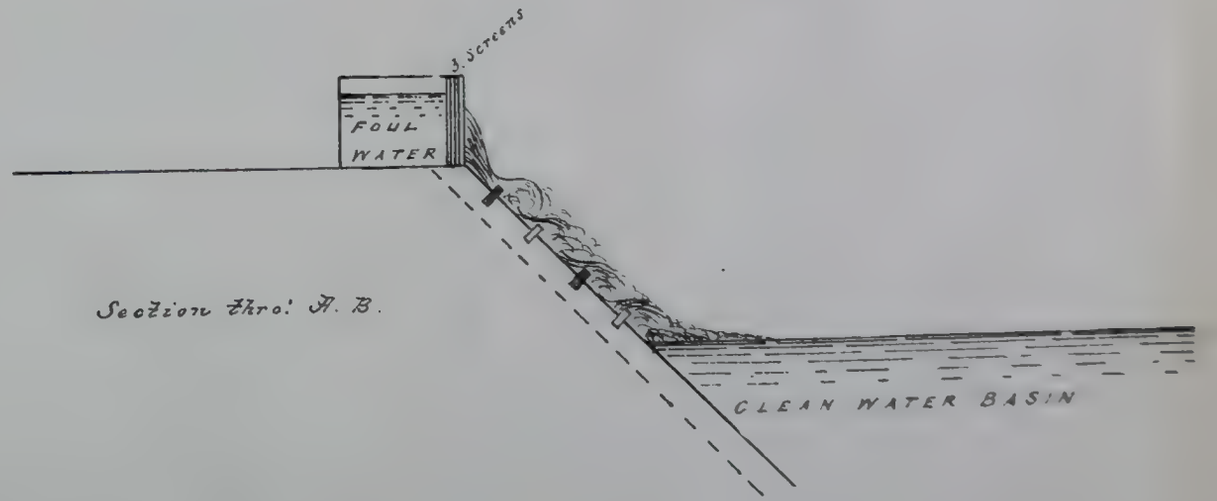


PLAN

SHEET. 2.

Plan of wooden "Screen Tanks" in use at Oakland Cal. prior to 1889.





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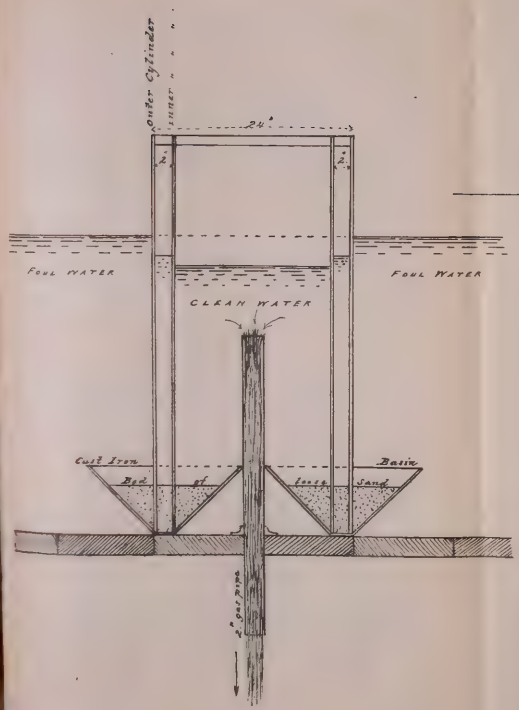
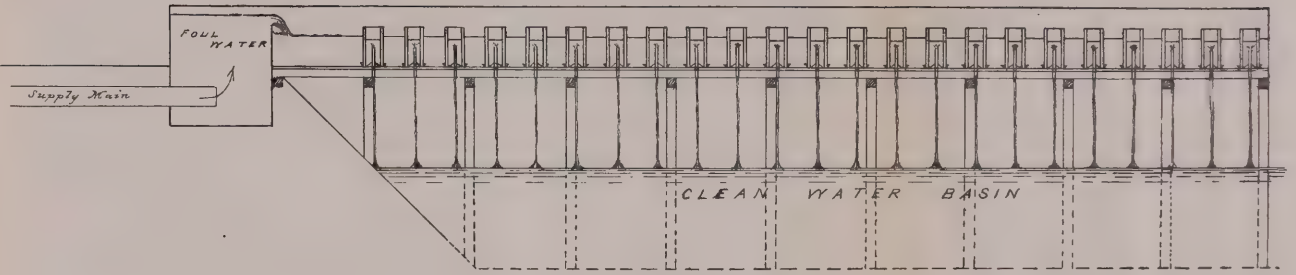
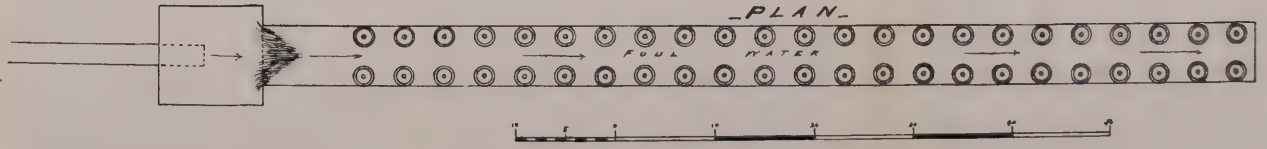
SHEET. 3.



Sketch of wooden "Screen-Tanks" in use at Oakland Cal. 1889





screens and thence through open flumes and aqueduct tunnels, and finally through wrought iron pipes to the city. At the outlets where they empty into the several service reservoirs, is located the so-called screen-house, where the water is made to pass through a system of cloth screens before it is allowed to empty into the service reservoirs. These cloth screens are constructed as shown in detail on Sheet 1. The sash frames are six feet long and two feet wide. Brass wire netting is tacked on and over that is stretched a good quality of cotton cheese cloth. In mid-summer, when the water is foul with animal and vegetable matter, the screens clog rapidly and have to be removed and clean ones put in their place. The fouled screens are taken to the wash-room, where they are thoroughly cleaned, and the foul wash waters are allowed to escape by a suitable drain pipe to the bay. Each one of these screen-houses requires the constant employment of double shifts, four men twelve hours each, raising, cleaning and replacing the screens. Some 300 being required for each house. Generally the water passes through two screens. When it becomes necessary to make a change, the outer screen being little fouled is removed first and a clean one quickly put in its place; the inner, or fouler one, is next removed and a clean one quickly put in its place. This screening apparatus is unquestionably very efficient in its way, but, as will be seen further on, it does not touch the fundamental seat of the chief trouble, which lies in the storage reservoirs. It should be mentioned that these service reservoirs have a division wall through the centre, thus enabling one-half to be emptied and cleaned while the other is in use. In summer this requires careful attention.

OAKLAND WATER SUPPLY.

The water supply at this city adopts a different method, in some respects, and it is interesting to know that the results obtained are much less satisfactory. Here the screen-house is placed at the storage reservoir, instead of in the city limits, and distant some 9.5 miles. Two varieties of screens have been in use, both identical in principle. Those introduced in 1879 are best shown in detail by the accompanying drawing (Sheet 2) with descriptive notes thereon. Those used in 1889 differ only in design. The foul water is made to pass through six thicknesses of cheese cloth wrapped around wire cylinders and the screening process is necessarily more efficient. This system is shown in detail on Sheet 3.

The screened water passes into a clean water basin, capacity about two million gallons, which is not covered. The hot summer sun has developed a large amount of vegetable growth in this basin and a second one has thus been built, thus enabling one to be emptied and cleaned when occasion requires it.

The screened water from the basins passes into the 37½-inch supply main, and travels slowly to the city of Oakland, and direct to the consumers, there being no service reservoir.

RESULTS ACCOMPLISHED.

In the case of San Francisco, the quality of the water delivered to the consumers throughout the year, may be characterized as reasonably good, and as a rule complaints are seldom made, and can always be traced to some local temporary cause. In the case of Oakland, however, the entire water supply delivered to consumers during winter, summer and fall, is always bad, but is reasonably good in the spring. In the

summer and fall of 1889, when the water in the storage reservoir got very low, a large number of citizens ceased to use the water either for potable or culinary purposes. They organized a company and brought spring water from the hills at considerable expense and inconvenience.

This extraordinary difference in the quality of the water naturally calls for an explanation.

After studying over the existing facts, I have come to the following conclusions:

First—Experience at San Francisco shows that the quality of the water is greatly improved by flowing through open flumes and aqueduct tunnels before it reaches the city. On arriving at the service reservoirs, the water is further improved by passing through cloth screens, and thence passes into the distributing reservoir, and *soon reaches the consumers before secondary deterioration in the pipes has had time to develop.*

Second—It is clear that the Oakland water company made a mistake in placing their screening apparatus at the storage reservoir. I sampled the surface water in the latter, and found it to be reasonably good, then I sampled the screened water near by, and found it to be much better. This screened water entered the supply main, and thence travels a distance of 9.5 miles to Oakland consumers. Experience shows that the *quality of the water delivered is always worse than the water in the storage reservoir.* This secondary deterioration is unquestionably due to the putrefactive fermentation in the pipe system. The water company now proposes to build a 150 million gallon settling reservoir within the city limits, and then transfer the screening apparatus to the same site. I have no doubt but that these new works will improve the quality of the water considerably.

These systems of cloth screens, when properly managed, have certainly proved to be quite effective, as far as they go, but they do not, in my opinion, strike at the fundamental seat of all the worst troubles. This conclusion is based on the results of a long series of observations, which have been under way for four years, and are still going on. They show conclusively that the main trouble from contamination in mid-summer is primarily due to the fermentation and subsequent putrefaction of the immense deposit of oozy mud in the bottom of the reservoirs. Hence the experience on the Pacific Coast goes to show, that generally speaking, *the older the storage reservoir the worse the troubles become.*

The immense deposits of mud in the bottom have been subjected to certain examinations. Its composition is found to be a mixture of vegetable and animal matter in all stages of decomposition interstratified with clayey sediment and vegetable mould brought in by tributary streams in the rainy season. The depth of this deposit averages ten feet and in places as much as twenty feet in the older reservoirs.

It is impossible to conceive how these storage waters can be maintained in a healthy condition as long as this source of contamination is allowed to exist. It must be removed, and the question is, how? In India this is done regularly by emptying the reservoirs, and cleaning them on the first of the monsoons, and then by closing the under-sluices they catch all the subsequent drainage. Of course this is not always practicable. I hereby submit a suggestion, which has developed itself during these examinations.

Samples of mud from the bottom were easily obtained in any desired quantity by means of an ordinary hand pump and 100 feet of stout rubber

hose. The same apparatus was useful in getting the temperature and samples of water at different depths. Now the facility with which this oozy mud could be pumped up, without disturbing the purity of the water in the slightest degree, at once suggested the idea of extending this system, and adopting it as a ready means of getting rid of this objectionable deposit at a comparatively small expense, and without emptying the storage reservoir. Also, I think it proper to state that a Gwynn centrifugal pump with a runner, 5 feet diameter, having a suction pipe 17 inches diameter and discharge pipe 15 inches diameter, was used under my inspection, to remove a large quantity of black oozy dock mud. The lower end of the suction pipe was simply allowed to sink down into the oozy mass. The engines were started up, and it was soon ascertained that this kind of material could be removed at the rate of 1,370 cubic yards per hour, and this rate was maintained for 9.5 hours, or a daily capacity of 13,000 cubic yards, and without changing the position of the machine. I merely mention this fact in order to show what has been done in this line.

The next question naturally arises, how will the material be disposed of? In some cases it could be discharged into the creek bed below the dam, and be carried off by storm waters, or preferably, if there be any shallow flowage or low land near by, heavy embankments of sand faced with gravel could be built, and material pumped behind them, thus making new high land, which would be greatly enhanced in value thereby.

RECAPITULATION AND CONCLUSIONS.

After carefully studying all the facts and circumstances obtainable so far, I am led to draw the following conclusions:

First—That the great deposit of putrid mud in the bottom of storage reservoirs is the primary cause which gives rise to the deterioration in quality of the water. That it should not be allowed to accumulate from year to year, as is generally the case, but should be removed from time to time, and the bottom kept reasonably free from animal deposits capable of undergoing putrefaction. That it is practicable to remove this mud at an expense not much in excess of that incurred in pumping water under like circumstances. That if this is properly attended to, the conditions which give rise to excessive vegetable growth will be practically removed, and as a result vegetable life will become so small in amount as to be a matter of little consideration. That as a final result the construction and maintenance of a system of filter-beds would become entirely practicable.

Second—That the troubles with the quality of the water delivered to consumers is largely independent of the contamination in the storage reservoirs, and can be traced to two separate sources, namely, turbidity during the stormy months, giving rise to deposits in the pipe system, which subsequently, when the water gets warm, takes on putrefactive fermentation, and gives rise to offensive odors during the summer and autumn. That neither of these can be properly removed except by means of subsidence followed by sand filtration.

Finally, if the above fundamental sources of contamination be eradicated as far as possible, I am of the opinion that the greatest of all reasonable objections to storage waters will be practically removed.

Mr. Tubbs: This paper suggests certain things to me. One is, the question of the taste in water that troubles us all. I am satisfied that these troubles arise from a microscopic plant. There are twenty different varieties at least known to bacteriologists that will produce a great many bad smells in water, I will not go into that at all but to my mind it represents three things: first, the propriety of using wrought iron pipes for conduits depends upon the condition and circumstances. The second thing is, we ought to investigate all these things and the third suggestion is this; there is not a water works superintendent here but what could get up a very interesting paper like that on his own water works. I think you should do it.

Convention adjourned at the regular hour.

Evening Session, May 20, 1890.

Meeting called to order at eight o'clock by the President.

The President: The subject under discussion is the paper of Mr. LeConte on the "Contamination of Storage Water on the Pacific Coast and the Palliatives resorted to." Professor Leed, of Stevens' Institute of New Jersey, will open the discussion to-night.

In opening the discussion on the paper of Mr. LeConte, Professor Leeds said :

Mr President and Gentlemen: I feel already well repaid to have come so far to attend this meeting by reason of the value of the papers I have listened to, and more especially this one of Mr. LeConte. Mr. LeConte has rendered a most valuable service by his contribution—the result of his studies of a variety of phenomena, very obscure in their origin, and which have much perplexed the minds of engineers. He has presented in an elaborate paper the results of observations made for a series of years upon the Pacific Coast, more especially upon the water supplies of the city of San Francisco and Oakland.

And now, Mr. President, if you and the other members will allow me, inasmuch as I do not think the discussion would be very intelligible otherwise, before saying what I propose to on this topic, I shall give a brief resume of the chief points of that paper.

In the first place, Mr. LeConte brings into prominence the unusual physical conditions prevailing upon the Pacific Coast: and, more particularly, the climate. He thinks that we on this side have no adequate comprehension of the difficulties growing out of these conditions. Mr. LeConte says that they are compelled to rely for their water supply upon

the rain which falls in their winter season between the months of November and May. After this period, for a period of six months they have no rain, and their storage system must be regulated accordingly. It is very usual for a whole winter to pass, and sometimes more than one, without any rain. The period of drought may extend to six hundred days, and they must have reservoirs to give them a water supply reaching over nine hundred days, or more than two years supply. The city of San Francisco has three reservoirs on a scale of which we have little experience on the Atlantic Coast. One of these reservoirs has a capacity of 1,080,000,000 gallons; the second 6,690,000,000, and the third 3,830,000,000. The amount of water supplied to the city from the first two reservoirs is 9,000,000 gallons a day, or only a little more than 1-1000 part of their united capacity.

The city of Oakland, he further says, has a reservoir of 4,300,000,000 gallons capacity, supplying twenty-two million gallons per diem, or about 1-200 of its capacity.

In a very lucid manner he describes the life history, if I may so call it, of the water as it falls from the clouds, is impounded in the reservoirs, flows down from the aqueduct, and finally reaches the consumers. He divides this life history into three stages. First, the period of collection extending through the winter season up to the end of May. During this time the water is good, notwithstanding some light silt or mud is carried into it by winter floods. He makes the important observation that up to the end of this period of collection, the temperature of the surface water is forty-eight degrees Fahrenheit, of the bottom water is fifty, and since the warmer water is below and the colder at the top, there goes on during this first phase of the life history, a constant circulation.

The second phase, he calls the period of fermentation. This sets in about the first of May. The surface of the water now acquires a temperature of sixty-two degrees, while the bottom retains its temperature of about fifty. As a physical consequence, the circulation ceases and this perion of fermentation is also a period of stagnation. This second phase of the life history is attended with a growth of phenogamous plants; that is to say, ordinary fresh water plants, plants capable of giving up oxygen, assimilating carbonic acid, supporting fish life, etc. Later, the era of fermentation is marked by the rising of bubbles all through the water, which consist of carbonic acid gas and carburetted hydrogen. As these gases increase in quantity, the dissolved oxygen diminishes and the vegetation changes its character. It is no longer phenogamous; it becomes cryptogamous, the familiar plants which flourish in lively water disappearing and the more obscure forms of vegetable life, the algæ, making their appearance.

Now comes another and more tragic phase of the life history. First, the youthful life with its beauty, then its development, then approaching decay. Now, there has arrived the last phase, which is that preceding death, and this last phase is one of putrefaction. When this has arrived the gases have changed their character. The oxygen has largely disappeared and carbonic acid gas, carburetted hydrogen and suphuretted hydrogen have taken its place. In the phase of putrefaction, decay is going on, and whenever decay occurs in the absence of oxygen, it is dangerous and means death, it means the formation of septic poisons, fatal to both vegetable and animal life.

This period of decay ends with the close of October. In November the life history enters again upon a new cycle. The frosty nights set in soon and the water becomes chilled. The chilled water sinks to the bottom and once more circulation of the water in the storage reservoirs takes place with consequent alterations and changes. Curiously enough, at this point, the water as shown by analysis is at its worst. This is due to the circulation having been established once more. The warmer water rising from the bottom along with the gasses brings mud and organic impurities to the surface. Mr. Le Conte emphasises the fact that while the water in the storage reservoirs is very bad, yet as it passes down the open flumes and acqueducts leading from the reservoirs, being in contact with the air in these open conduits, its quality continues to improve progressively until by the time it reaches the surface reservoirs it is at all times much better than the water in the impounding reservoirs. He further discriminates in this connection between the changes taking place and the resulting quality of the San Francisco water, and the city of Oakland water. Both are provided with enormous impounding reservoirs. But the San Francisco water comes down through open conduits and passes through screens placed at the service reservoirs within the city limits. The city of Oakland water, on the other hand, passes through screens placed near the storage reservoir amd then flows many miles out of contact with air before it is delivered to the consumers. It results from these differences that the quality of the water in San Francisco, is far better than the city of Oakland water. Furthermore, in regard to the city of Oakland, an additional source of the offensive taste is in the pipe system. During the entire putrifaction stage in the storage reservoirs, the water in the pipe supplying the consumer is always bad. Mr. Le Conte attributes this offensiveness to the mud in the service pipes and finds it so much the worse as this mud is excluded from the air.

In concluding this resume of the paper, I will bring to your attention the palliatives proposed by by Mr. Le Conte, his first palliative consists in the removal of the mud from the reservoirs. He proposes to effect this removal by means of a pipe let down to the bottom through which the mud should be pumped.

Secondly, the accumulation of the mud in the service pipes should be remedied by previous subsidence and sand filtration.

I have now given you as fair an idea of the contents of this valuable paper as I could from my recollection of it as read. I am deeply interested in this matter, but I should not refer to any points in my own experience, or make any criticisms upon the palliatives Mr. Le Conte proposes, unless I felt sure you were willing to devote more of the valuable time of the convention to its consideration.

MR. TUBBS: Prof. Leeds has probably given more attention to the examination of water supplies than I think any other person in this country, and I desire that he should give us the benefit of his views on this valuable subject, and I now so move. Carried.

MR. TUBBS: The professor has not gone quite far enough in this matter, and Mr. Le Conte has not gone far enough. If the professor would favor us with a few

suggestions I should be personally pleased about it, and I hope the president will request him to make a few more additions to his remarks.

THE PRESIDENT: It is the opinion of the chair that the convention would like to listen further to Prof. Leeds.

PROF. LEEDS: In the first place Mr. President, I am sorry that I gave no personal knowledge of the climatic condition prevailing on the Pacific coast. But the troubles which Mr. Le Conte speaks of, are similar to those which baffle and perplex all of us, perhaps more than anything else in connection with the palatibility of particular water supplies. To show that these troubles are very common in the Middle and New England states, I would mention that in the summer of 1874, the state of affairs Mr. Le Conte speaks of as chronic in the California storage reservoirs, occured over the whole of the northern part of New Jersey. Mr. Owen, our fellow member, said to-day that in accordance with the recommendations of the Water Commission, of New Jersey the whole of the water supply which falls upon the Passaic water-shed, of northern New Jersey which is 900 square miles in area is to be parcelled out, and so many million gallons are to go to the city of Newark, so many to Jersey City, and so on. But while the remark made by Mayor Haynes, of Newark, that this water is of great purity, is true of the water in its ordinary condition, in the natural impounding reservoirs, which are the lakes all through this water shed, the same trouble that Mr. Le Conte speaks of frequently occurs. In the summer of the year 1874, if I recall the date correctly, there was not a lake in this water-shed which did not present the same phenomena and go through the same changes of fermentation. The fish were affected by it, a vast number dying and rising to the surface, being killed by the poisons generated in this process of purification. The country people recognize the re-current character of this aquatic disorder, and denominate it "the purging of the water."

I spoke of New England. At Athol, Massachussetts, for instance, the water is taken from a natural impounding reservoir, and every season it goes through the same cycle. Not only the period of fermentation and of algæ, but of putrefaction attended by an intolerable stench. At Springfield, Massachusetts, the Ludlow reservoir covers 550 acres and they have tried a number of palliatives, especially gravel and charcoal, but without success. The water supply of Newburg on the Hudson, and very many other towns in the Middle states have their like periods of fermentation and putrefaction.

It a mistake to suppose that troubles from aquatic vegetation take place only in the warm season. Our friend, Mr. Tubbs, will back me up in the statement that in connection with the water supply taken from Hemlock lake at Rochester, they have had trouble in winter quite as bad as in summer, due to the development of different forms of algæ. There are certain kinds that will grow on the ice and they have suffered on this account at Rochester in the month of February. The same thing was true of the water supply of Philadelphia in the winter of 1882. The water supply at Philadelphia comes mainly from the Schuylkill river, which has a daily flow of nearly 300,000,000 gallons. At that particu-

lar season, the river was coated with ice from Pottsville and the mining district, down to the Fairmount pumping station. Many of you who visited the centennial in 1876 will probably recall that there was a great many cases of typhoid fever among the visitors at Philadelphia at that time. The origin of the typhoid fever prevalent among the centennial visitors was attributed to the polluted water of the river Schuylkill. I am glad that when we shall all come to Chicago to your World's Fair, one of the exhibits which you can be most proud of, will be your unlimited supply of unpolluted water. The examination of the water at Philadelphia in 1882 showed that it was very impure, but the cause of the offensive taste and odor was not revealed, until the analysis was extended to the gases dissolved in the water. This examination showed that the oxygen had disappeared, and its place had been taken by carbonic acid and carburetted hydrogen. These changes had come from the putrefaction of the sewage contained in the Schuylkill water beneath the ice, and consequently out of contact with the air.

I shall have a few words to say with regard to the nature of the remedies that appear to be indicated. Mr. Le Conte dwells upon the importance of the removal of the mud from the bottom of the reservoirs, and on keeping it out of the pipes by subsidence and filtration. In reference to the former recommendations, I would add the importance of preventing the process of fermentation and putrefaction in the reservoirs, by eliminating the dissolved carbonic acid and carburretted and sulphuretted hydrogen by means of excess of oxygen. These two objects are being carried out in a number of places by artifical aeration. Water, after this treatment, does not require preliminary subsidence. Its suspended mineral matters can be completely removed by precipitation and filtration, which at the same time removes all other particles however minute, including the spores of bacterial and cryptogamic life.

Mr. Haynes : I come from a district where we have a great number of fresh water lakes, and the process of purging, as it is called, takes place each year. A portion of the lakes are in New York state and the others in New Jersey, and they have a very limited water-shed. In addition to my labors as mayor I am president of the Newark Aqueduct Board and also the Board of Health. The railroad from Glenwood lake brought ice to the City of Newark. It was supposed any ice was pure anywhere from that lake. We were notified to make an examination of that ice and did so by cutting off or shaving off carefully enough of the ice to obtain a gallon of water, and sent that to Rutger's college where it was analyzed by their chemist. About the same time our surveyor took a quantity of water from the stream where it entered the Passaic river and sent it to the same chemist. When it came back, to our surprise, he had found that the water that was taken from the stream, that we looked upon as very impure indeed, was chemically purer water

than that taken from shaving the ice. We found that a year ago the canal company raised a dam across the outlet of Greenwood lake, raising the water some nine feet. The lower part of the lake was at that time covered with a forest. The timber was cut away and that gave us some idea of how that water became impure and unfit for drinking purposes. This water situated where there are an immense number of hat factories would look impure and unfit for drinking. Now, with this supply of water that has been spoken of, this afternoon at Oak Ridge the engineers have commenced their operations and there we expect an impounding reservoir of four and one-half billion gallons. At another point, at Glendon reservoir, we shall be able to impound 3,500,000,000 gallons, but the shops will be some six or more miles from this point. The water will have an opportunity to pass over this distance on a bed of gravel and then down over the river bed where there are an immense number of rocks and where it will be exposed to the sunlight and then in through the pipes from which we expect to receive our water, coming some twenty-five miles to the City of Newark, and we expect to have as pure a supply of water as is possible to have anywhere in the United States. The Passaic river is a tidal stream. The water is exposed to the sunlight and to the air, moving backward and forward with the tide every day ; and we find that our water, according to an analysis made by Prof. Leeds, was declared to be purer than that at the famous Croton Water Works.

SECOND DAY.

MORNING SESSION, Wednesday, May 21, 1890.

Convention called to order by the President at 10 a. m.

THE PRESIDENT: The first order of business is a paper by Mr. Darling:

DESIRABLE EFFICIENCY OF HYDRANTS IN CONNECTION WITH WATER WORKS.

The topic I shall discuss to-day is one of the most important that is connected with Water Works. Why do cities or towns expend great amounts of money to introduce water? First and of the most importance, to protect their property from fire, and second to furnish water for domestic use and the supply of boilers, etc., for manufacturing purposes. Now the suppression of fire is the most important factor we have to contend with. To enumerate the causes that have been positively ascertained, would be useless. Convince the citizens of any city or town that they have a good fire protection, and the Water Works become popular. In the first place the mains should be of a sufficient dimension to supply with ease the hydrants placed thereon, and they should never be less than six-inch inlets. Many cities and towns make a great mistake in trying to reduce the cost of the works by using small mains and small hydrants. I can recall to mind instances where ten, fifteen or even twenty hydrants are placed on a six-inch main with no reinforcement, and the citizens expect that all of them could be used if wanted. Now it is a well known fact that four good fire streams is all that can be expected from that class of mains. I am reminded of an instance, related by a friend, where two competing fire companies were trying to put out a fire in a house, and each one was using two hydrants situated on a six-inch main, with no effect on the fire, and as neither would give up to the other, the house was burned. Now if both companies had shut one hydrant each, they would have been effective, and the house would have been saved. Another mistake that is made, is locating hydrants too far apart, where you have mains of sufficient magnitude to supply. Hydrants are cheaper than hose, and will last longer with less care, besides you get better results with short lines of hose. The friction in the hose overcomes the pressure, and the effectiveness is lost to a large extent. The relative cost with the life of the hydrant in comparison with the life of the hose, is largely in favor of the closeness of hydrants. Yes, but they say the hydrants cost money; admit it does, what is the cost in comparison to its worth when you want it, and the location of one hydrant might save a hundred-thousand-dollar conflagration or even more. Ask your chiefs of the fire department if they think you have too many hydrants where the pipes are of the capacity equal to the demand, and they will tell you no! But where they are not, the fire de-

partment is often censured for that which they are not to blame for, and in most of the cases the cause is traced to small mains and hydrants for economy. The hydrant is looked upon by some as a useless thing because it is not used, or in other words because we do not have fires. We have on our works hundreds of hydrants that have never been opened for fire purposes in the past ten years, and yet I would not know where to discard one; in fact we do not wish to use them only when we have a fire, and then they are wanted more than their value. We never want a fire; it is like the insurance on our houses; we pay, but do not want them to burn. I remember a few years ago some of our citizens said we did not use them and therefore ought not to pay for them. About that time we had a large lumber yard on fire and it was a very dry time and the wind was blowing in a direction which carried the sparks over the business part of the city. At one time we had the roofs of sixty buildings on fire. The hydrants were brought into service, playing fifty-two fire streams in that location, and in connection with the sill-cocks, which nearly every house has for garden hose, a conflagration was prevented which was liable to have cost a million of dollars. These same people said after that there were no useless hydrants in the city; and it is a fact, the hydrant that may be looked upon as useless, may save thousands of dollars of loss. All hydrants should be easy of access, and to have them so I believe the post hydrant is the most effective. I also believe the independent gate on each outlet for the hose is of more value than the extra cost of the same, and the day is not far distant when they will be more universally used. Our experience with them, as we have no other kind, is, I believe, to be of ten fold value. To illustrate: take a fire just started; with two or four streams playing and one line of hose bursts, you have to shut off the other streams to replace the hose. During the delay the fire may get such headway as to cause great damage, but in the use of the independent gate the other streams play right along. The first minute on a fire is worth hours at some other stage of the conflagration. To be sure the firemen have chucks which are screwed on to the hydrant or hose, but they are unwieldy in comparison with the gate. I think that if firemen should use the hydrant with independent gates, they would say just as I do. I know from experience that where you have a heavy pressure, you can regulate it with the gate very easy. Superintendents of works should always look well in making extensions of mains to the efficiency of the hydrant. Another important factor is fast coming into use, the automatic Sprinklers, used only in case of fire. They do their work before the hydrant is called for, and in case they fail by some unforeseen circumstance, which hardly ever occurs, they should be governed by gates so that when their efficiency is gone, they can be easily shut off in the street. They are undoubtedly of untold value as can be practically illustrated any day in cities where they are in use. We have in our city miles of automatic sprinkler pipe, and fires occur daily that are never reported. Hydrants never should be used only for fire purposes, only in cases of necessity. Some cities allow them to be used for sprinkling carts or watering down the streets, and other purposes, by inexperienced men. Then the firemen find them out of order and the superintendent has to stand the blame, as no one knows who did it. They should be inspected as often as twice a year and properly oiled, but never inspected in extremely cold weather, as by the introduction of water they are liable to stick with frost. Of course there are cer-

tain kinds of flush hydrants that have to be looked after in extreme cold weather more frequently. With an experience of ten years with from 400 to 800 hydrants, we have never had but little trouble with frost. Ours are post hydrants with rubber disks, and shut against the pressure, and I have never had to remove one as yet. After having built your works it is well to know what you can do if called upon in extreme cases. I had faith to believe we could play seventy fire streams at once and maintain eighty pounds pressure while playing, and I so stated at the last convention at Louisville. On September 19, 1889, our Chief Engineer, Mr. John Brierly, was invited to play seventy one inch fire streams through fifty feet of hose, at once. This was successfully accomplished, holding a maximum pressure of eighty pounds during the time the test was made. The test was made on the twenty and twenty-four-inch force main, three and one-half miles long, leading from the pumps through the centre of the city to the storage reservoir on the heights, at an elevation of 301 feet above tidewater, the engines with a capacity of 12,000,000 gallons all being running. Four thousand and forty feet of this main was used, and the streams were taken from nine six-wayed and eight two-wayed hydrants. Four Edson recording gauges were placed on the line located so as to give the best results of the loss of pressure, and one before each pump. The cards show with what nicety and precision they exemplify and verify the pressure. By the use of these gauges we were enabled to verify facts which we should have been unable to do without them. The pressure at the No. 1 engine which was the nearest to the draught of water was reduced twenty-four pounds; at the No. 2, ten pounds, and at the No. 3, ten pounds. We were delivering during the trial 15,500 gallons per minute. The capacity of the pumps was 12,000,000 gallons per day, and the draught on the reservoir was 10,000,000 gallons per day, including the supply of the city at the same time, making a consumption of 22,000,000 gallons per day. I am satisfied that by distributing the hydrants over a larger territory we would be able to play 100 fire streams and retain the same pressure. Some prophesied that we should blow the pipe up or the hydrants off when we closed them, but we had no such result, as will be seen by the cards which I present you with as shown on the blue print, which also shows the situation of the main and all reinforcements, and location of the hydrants.

In conclusion I would say that I have tried to give you a practical result of the efficiency of hydrants where you have a good pressure, and mains large enough to supply the demand. I contend that originators of Water Works should always bear in mind that the efficiency of the hydrants is of the most importance, and should always be looked after with the greatest care. Superintendents having charge of works in making extensions should always try to connect all dead ends, so as to reinforce the supply to the hydrants, and make them more efficient as their works increase in magnitude.

Permit me to quote the following from *Fire and Water*, of May 3d, which endorses my position on this subject :

"Speaking of the miserably inadequate number of fire hydrants in the streets of New York and the manner in which the fire department is thus handicapped in the discharge of its duties, the *New York World* expresses in a very few words just exactly what could readily and should be done in the matter of a city of such extent and wealth. The department of Public Works, which has charge of the furnishing and the set-

ting of hydrants, having frankly admitted the justice of Chief Bonner's claim, that many more hydrants are needed, but asserted that the available appropriation will not permit of laying the mains necessary to supply them, the *World* quietly says: 'The only answer to this is that if the money necessary for anything so important as this be lacking, more should be appropriated. A big city cannot be run without some expense, but no reasonable citizen would complain of the cost in a matter of such vital importance. Have more hydrants, if it does cost more. And that is all there is to it.' "

Chief Scannell of the San Francisco Fire Department with the aid of his most powerful engine recently gave the grand jury and the mayor and supervisors of that city an ocular demonstration of the crying need for proper protection against fire of additional fire hydrants. Of course these gentlemen knew well that in many parts of the city the distance between the hydrants was from 1,500 to 2,000 feet, but it is probable that they never before realized so thoroughly how great was the loss in power of a stream caused by the friction in the long line of hose thus made necessary. It is safe to say that they were somewhat surprised when, after seeing water thrown 206 feet through 100 feet of hose, the pressure at the nozzle standing at ninety pounds; 900 feet more of hose were coupled on and the enfeebled stream fell to the ground just fifty-four feet from the nozzle, where the pressure mark was but six pounds. If the San Francisco authorities do not, after this exhibition, provide the new hydrants asked for by the Fire Department, they will show themselves either extremely obtuse or remarkably indifferent to the safety of the city. As Chief Scannell tersely said, referring to the trial with the 1,000-foot line: "With that stream of water I couldn't reach the top window of a three-story house with sufficient force to break the glass;" and yet it is pointed out that the need for lines of 800 feet is not uncommon in that city, and that at one fire not long since water had to be forced 2,000 feet by two steamers to get a stream upon the second story of the building ablaze.

EDWIN DARLING,
Sup't Water Works, Pawtucket, R. I.

MR. DIVEN: Mr. Darling states in his paper that he considers water supply for fire protection as of the first importance. I think that the public health is far more important. I think good pure water should be the first consideration. After that we can take care of our property. Then he speaks about inspection in cold weather. We inspect in cold weather. We open the valve enough to show that it is not frozen. What little water gets into the hydrant is immediately pumped out, with a small pump. Again he speaks of a difference of pressure. Now we do not pretend to give fire pressure in our town; with a pressure of forty-four, which is a very low pressure to try hose; we found that we threw a better stream with one and one-eighth or one and a quarter inch nozzle than we could with an inch, and better with an inch than we did with a three-quarter

inch; but when we come to using long lines of hose we found that our stream from one inch or seven-eighths inch was the best, but on two hundred feet the one and a quarter inch threw a better stream. I presume the idea is that the small stream spreads more. Have you made that test, Mr. Darling?

MR. DARLING: I don't doubt but that is a practical result in the way stated. I desire to say that to procure seventy nozzles in a city like ours it would be very hard work to get them from the fire department. We had twenty-five or thirty nozzles and had some forty I think, made for the purpose. I call them inch nozzles; for I would rather be on the safe side, they will measure anywhere from an inch to an inch and an eighth; some of them almost an inch and a quarter, and I certainly know we had ten or fifteen inch and a quarter nozzles playing at the time, but I don't desire to make that statement in the paper. I would rather be on the safe side and say there were seventy one inch streams. Our fire department uses almost invariably one and a quarter inch nozzles, except when we want to flood the building, then we we put on two and a half inch nozzles.

MR. DIVEN: Do you consider seventy-five or eighty pounds sufficient for all fire work without any reserve steamers?

MR. DARLING: I consider that eighty pounds pressure for our city would perhaps accomplish the work, but I would prefer one hundred pounds. It is hard to get just the pressure you want. I am well aware that there are but few water works in the country that have one hundred pounds pressure. I am well aware that we have to adopt ourselves to the situation and that was what we did there, and in laying our mains, I refer to the size of the mains, we put thirty inch main through the city to start with and it was looked upon by some as unwise ; but I think it was the wisest thing that we did and I must say it is the wisest thing for any one in building water works to put pipes larger than the present consumption demands. The growth of a water works is beyond comprehension in any city or town where they are introduced. Most people think that it will not grow any. They tell you you

will not be able to do anything because you are not going to get people to take your water. Now you show the people that you have an effectual fire protection and they will take water every time, providing you have palatable water, and I am presuming that no city or town is going to introduce poor water into the town. Now in reply to the gentleman who takes the ground that public health is more important than fire protection I take the ground that the fire is first, connected with the public health of course, and if you introduce good water you certainly have produced what you want to do if you introduce it for domestic purposes, and you don't need to have this amount of pressure. If you have got twenty-five pounds for domestic purposes it is just as good as a hundred and often better so far as that is concerned. I do not know of a city or town, and I hardly think that the gentleman will say that he knows of one, that when they introduce water works they did not provide for fire protection, either by direct streams from the hydrants or by the intervention of fire engines.

MR. DIVEN: There is one more advantage in the large main besides keeping up the pressure and that is by increasing the size of the mains we reduce the water hammer.

MR. SICKLES: I would like to ask how long the gentleman kept up these seventy, one inch streams.

MR. DARLING: About eight minutes.

MR. SICKLES: If he was pumping at the rate of twelve millions and with ten millions in the reservoir, he would be using double the actual capacity at the time of throwing those streams. I want to know if such a thing was practicable for any longer time than a few minutes.

MR. DARLING: It was not quite double because that would be twenty-four millions. We could maintain that play for twenty-four or thirty-six hours. We would depend upon the reservoir and our pump.

MR. SICKLES: It shows the advantage of the reservoir over the Holly system.

MR. CALDWELL: The paper raises the question in my mind as to what percentage of water is used for fire as against the percentage used for domestic purposes.

MR. DARLING: Our percentage is very small. We have very few fires. Of course, we are largely protected by the Automatic Sprinkler which is worked before the fire alarm is given and I may say, we have daily fires that I never know anything about. Of course, many of you gentlemen here are connected with private works, where the city or town pays you so much for the hydrants per year, if they do not have any fires they do no use your hydrants and therefore they say, as we do not use your hydrant waters we ought not to pay you anything for them.

MR. CAMERON: I would suggest that the proportion of water used for fire and domestic purposes occupies about the same position that the pipe question did yesterday. It depends entirely upon how many people wanted to sell out their stock of goods on account of no business. Sometimes you will have a hundred fires in a month and sometimes you will not have one in a year.

MR. LAKIN: I will state for the information of the gentlemen that during 1887 I attempted to make an estimate of the amount of water used in extinguishing fires. We pumped about two million gallons per day and had 87 fire alarms, out of which 46 were actual fires. The amount used by pump displacement in addition to our regular domestic use was so small that I was ashamed to put it on record. I can safely say that out of a little over 700,000,000 gallons pumped, the amount used for fire purpose was less than three millions above our daily domestic supply on the days on which the fires occurred. I am keeping the same record this year for my own information.

MR. DIVEN: I would say that the annual percentage is of no great importance. That percentage is often used in twenty-four hours or often less. In a small city a capacity of about two million gallons per day above domestic use is required for fire protection. This gives water enough for extinguishing fires without interfering with the regular supply.

MR. COLWELL: The gentleman from Rockford stated that three million gallons were used for fire during a year while some seven hundred millions were used for domestic purposes. That figures out about four-tenths of one percent. and it gives great force to the remark of Mr. Diven that water supplies are for some other purpose. While they are good for fire they are very much more important for domestic use.

MR DARLING: I do not deny that domestic use steps in, but I do claim in connection with domestic use that fire service is the most important in any city or town.

A DELEGATE: It seems to me that this question of water supply is like the Texas man's revolver. He does not want it very often but when he does want it he wants it bad.

MR. DECKER: I kept the record last year and find that the percentage is a fraction less than one-tenth of one per cent. of the amount pumped, and I kept a very acurate account.

MR. DARLING: I believe one per cent will cover any case that you can find. Of course there is a variation for each circumstance.

MR. BENZENBURG: That very discussion was brought up in the American Society of Civil Engineers and it was conceeded that one and one-quarter per cent. was a fair estimate of the amount of water used for fire purposes. I have made some little tests on that myself and I was really astonished at the small amount of water being used at a large fire that was raging for some eight or nine hours. It was so small that it was really not worth speaking of. There is one feature in Mr. Darling's paper that I cannot agree with and that is that the hydrants should not be inspected during the winter time. I think that it is very necessary that they should be inspected especially in the centre part of the city. I have had some experience on that subject. I believe you all remember the Newhall House conflagration. Two hydrants immediately on the opposite corner were discovered to be frozen about ten or eleven o'clock that morning in the rounds of inspection and means were immediately taken to thaw them out and put them in service

again, and it was only at five o'clock that afternoon that those two hydrants were restored to service. Both of these hydrants were the hydrants that were first put in service in combating the fire. You all know the terrible loss of life that occured there and what I want to call your attention to is that if both or either one of these hydrants had been found frozen that the responsibility for the entire loss of life would have been placed to the Water Department and no one in the world could have gain-said it or found a reasonable excuse, as it was the loss of life took place anyhow, proving that if those hydrants had been frozen it could not have been any greater, but if those hydrants had been found frozen, the responsibility would have been thrown on that, so for my part I make it a point never to let a hydrant go uninspected.

MR. DARLING: May I ask how deep the pipes are covered and how deep it freezes.

MR. BENZENBERG: About six feet and it freezes six feet or six feet and a half, but we have not had any frost in our pipes for twelve years. We have had frost in the hydrants, but none in the mains because of the circulation. Of course, where the frost is as deep as the mains, if it were not for the circulation the mains would freeze up.

MR. DARLING: I don't want to place myself in a wrong position. I believe when you get the thermometer twenty below zero, everybody will begin to howl about your hydrants. I believe that when it is in this stage it is unsafe to let the water into these hydrants, because just as sure as you do the hydrant will stick. If the frost is seven feet in the ground, or the depth of your pipe, and you let the water into the hydrant it will stick. The gentleman remarked that he just opened it enough to show that it was all right. I will not object to that but when it is ten or twelve below zero the minute you open the hydrant and let the water in you take a chance that you don't want to take. If you simply open it a small ways and see whether it will turn or not there is no danger in doing that any time of the year.

MR. RICHARD: Some time ago we had a very cold spell down in Atlanta and the chief engineer of the Fire

Department requested that we make a general inspection of the hydrants. Now, I notice that the greatest trouble was that the water got up to the stuffing box and that the rods were frozen stiff, but we didn't have any trouble with the valves. The valves were all right. If you just open your valve sufficient to raise the water to the nozzle and not carry it to the stuffing box there is very little trouble in opening the valve unless the valve is frozen.

MR. PRIDDY: I suppose I have tested as many hydrants as any man. There are three months in the year I have to open every hydrant, when the thermometer is from ten to twenty below, and I find it is absolutely necessary to test every hydrant by letting water run, because quite often if you want to test it to see if it will turn or not you simply test the stuffing box above. You may turn it a little way and some water is bound to come out, and as to the water coming into the stuffing box, it is as liable to come there from snow on the outside, and I hardly ever have any trouble with it freezing inside.

THE PRESIDENT: If there is no further discussion on Mr. Darling's paper, we will proceed to the next order of business, which is a paper by Mr. Donahue.

SIMPLIFIED METHOD OF BOOK-KEEPING FOR WATER DEPARTMENTS.

BY JAMES P. DONAHUE.

"I do not know of a subject of more practical interest," are the words of Mr. Decker, our worthy President, in expressing his idea of this subject. Mr. Diven read an admirable paper, at Louisville, on Water Works Records, and in concluding he says, "It was my intention to collect and describe the various forms used in water offices for applications, plumbers' permits, accounts for water rents, etc., but the great variety which I found in these forms made the task a difficult one and would have made this paper entirely too long, so I will leave this subject for some one in search of material for a paper, and will guarantee that they will find plenty of material." I agree most thoroughly with Mr. Diven as I have found the task of devising a simplified method of forms very difficult, on account of the varying ideas of water works men as to what style of forms should be used. There is nothing, I fancy, connected with water departments in which we as a whole so widely differ as in the forms used for keeping our accounts. I have had forms from many water works to guide me in my work, and I find we differ mostly in the form for a Consumer's Record. I have, therefore, given most of my time to that book, but I may mention the principal forms used in water offices as follows:

Consumers' Application for Water.
Consumers' Permit for Connection with Mains.
Plumbers' Return or Report.
Inspection Blanks.
Rate Blanks.
Inspection Book or Record.
Meter Record.
Consumers' Annual Rate Record.
Classified Record of Receipts and Expenditures.
Engineer's Record of Performance of Pumping Engines, Coal Consumed, etc.

As Mr. Diven treated forms in general in his paper (See page 18, 9th Annual Proceedings American Water Works Association), I shall adhere more particularly to financial records, giving only crude reference to other forms.

CONSUMERS' APPLICATION FOR WATER.

In nearly all water offices a book is kept for this particular purpose, and a person desirous of obtaining a supply of water must come to the water office and make formal application. It is generally required that the owner of property should sign this application. There is then issued to him a formal permit, giving permission to plumber to make necessary tap or connection. I cannot well recommend any particular form for this purpose, as it may be necessary to have wording, to cover local rules and conditions. Instead of an application book, I favor a printed form of contract such as in use in Kansas City, Leavenworth and other places. Where a property changes ownership, but water remains turned on, bills being paid promptly, it often happens that the new owner is not holden to the water company for reason, perhaps, of neglect to call and sign application book. With the contract form, your inspector can call upon him, get signature and thus save the demanding that new consumer to come to water office and sign application book. I consider it good policy to study the convenience of our customers and have as little "red tape" about an office as possible.

THE PLUMBERS' RETURN OR REPORT

In style varies according to the local conditions and relations existing between the water department and the plumber. Where plumbers are under bond to make reports, the form materially differs from the style of report where plumbers have no restrictions requiring reports. In the latter case a plumbers' return is a curiosity, a thing in fact worthy of being framed and hung in the office to scare burglars out.

THE CONSUMERS' RECORD.

For sake of brevity and to give as much information as possible, in concise form relating to each tap or consumer, I have combined in one form the Consumers' Record, Inspection Book and Meter Record, giving first the tap and connection number, location of premises, location of stop box and size of tap. Then in a small column to the left I have the inspection, next the consumer's name with room enough for a change every month if necessary, the record of turn on and turn off's, the record of water rents, amount, when paid, and folio of cash book. I have arranged space so as to cover monthly collections, if rents are so collected, or if collections are made quarterly I have every third line ruled red, dividing

WATER WORKS.

TAP NO. PREMISES NO. STREET.

CONSUMER NO. LOCATION OF STOP BOX SIZE OF TAP.

INSPECTION.	CONSUMER.	On.	Off.	WATER RENT. From.	WATER RENT. To.	Amount.	When Paid.	Cash B. Folio.	Date of Reading.	State of Meter Cubic Feet.	Cubic Feet Consumed.	Gallons Consumed.	Rate per M.	Amount.	When Paid.	Cash B. Folio.	Remarks.
Dwelling Rooms																	Size of meter,
Bath																	Kind of meter,
Water closet																	Kind of service,
Urinal																	
Hose, Lot																	
Stable, Horse																	
" Cow																	
Store																	
Family over store																	
Office																	
Factory																	
Steam engine																	
Fountain																	
Special																	
Saloon																	
Barber, Chairs																	
Annual Rate																	

each quarter separately. Then follows space for keeping a meter record, should the premises be metered. First space date of reading, the state of meter, cubic feet consumed, gallons consumed, rate per M., amount, when paid, folio of cash book and remarks, in which I have space for size and kind of meter and kind of service, whether lead or iron. I have combined the meter record and the record of annual rate collections into one form, for I think it of an advantage to have them so arranged as to be able to find out what a tap is earning, and get complete record without having to refer to several books. This is an original idea and may or may not meet with approval from members, but as we can only learn from the criticism and experience of others, I hope the members will be kind enough to offer suggestions so that I may be able to make such changes as may be considered of advantage. In many records a space is found for the name of the owner of property as well as the consumer, which I have omitted. We deal with the premises and endeavor to get owner to pay water rents, regarding him as the consumer; while I admit that in some cases it is important to know who the owner of property is, this occurs but seldom and when it does it is very easy to get the desired information. This book I think is arranged so as to give a complete history of the "tap" and everything pertaining to it, whether the consumer be of the annual rate class or a consumer by meter measurement, deeming it of material advantage to have the account so arranged as to have the meter account kept with the annual rate account, so that both can be compared if necessary, and it frequently occurs. I do not mean by this that premises will be paying water rent by meter and annual rate at the same time, but often meters are put on premises that have been paying an annual rate and then taken out and a new or different rate adjusted. When this occurs it makes a record or what might be termed a sort of history pertaining to the tap, and my intention is to give as much history as possible in one account.

A CLASSIFICATION OF RECEIPTS AND EXPENDITURES.

Is a book not universally kept by water offices, but of sufficient importance to warrant its use. The accounts to be kept vary in nearly every department and make it difficult to formulate a book for general use. The same may be said of the Engineer's Report.

I might write an exhaustive paper on the forms for water offices, their uses and benefits, but the subject has twice been before our convention, and every water works man must feel the importance of system in his office, and no doubt knows the necessity of forms. I will then close this paper by putting on exhibition the numerous forms I have described and those I have gathered for inspection of members of our Association. I thank you for kind attention given me while reading this paper.

THE PRESIDENT: If there is no discussion on the paper read by Mr. Donahue we will proceed to the next paper on the programme, which is "The Merits of the Association and the Work Accomplished in the past ten years," by Mr. P. H. Linneen.

Fellow Members of the American Water Works Association:

For the tenth time we are gathered together to hold our annual meeting; to discuss the different topics of interest to ourselves and our

Association; to profit by one another's experience, and to so strengthen and fortify the bulwarks of our organization, that it will become, if possible, more stable and permanent in the future than it has been in the past. A brief resume of the Association, its formation, growth, good it has accomplished, and benefits to be derived from membership will not be out of place. The little grain of mustard seed sown by the Secretary of the Keokuk Water Company, when on March 29th, 1881, the first meeting at which this Association was formed was held at St. Louis, has grown to such proportions that now under its extensive branches can be found members from Maine to California and from the Gulf of Mexico to British Columbia. At this first meeting twenty-two reputable and responsible men engaged in the Water Works business responded to the call of Mr. Stripe. At this meeting the society whose tenth annual meeting we are now celebrating came into existence, and after a three days' session devoted to the discussion and consideration of questions which have proven to have been of great importance to all those engaged in the equipment and construction of water works plants, the child bloomed forth, full fledged with Colonel J. T. Foster, of Chicago, as its foster father.

At this meeting, J. H. Decker, our presiding officer, was elected Secretary and continued to hold and faithfully perform the duties of that office for nine consecutive years. The second annual meeting was held at Columbus, Ohio, March 14th, 15th and 16th, 1882. At this meeting a perceptible increase in the membership was noticeable. The same officers who were in power the year before were retained during that year. The several topics presented for discussion at that meeting and the very able papers read, proved beyond a doubt that the aims and objects of the Association were such as to offer proper inducements to all interested in water works matters to become members of the organization; and the increase of membership at the close of this meeting was certainly a decided inspiration to the originators of the Association to continue the good work begun the year before at St. Louis. The capital city of the great Buckeye state extended to our infant organization a most royal welcome. The mayor and other city officers were indefatigable in their efforts to make the stay of the delegates pleasant and agreeable. After three days' effective work the whole-souled and liberal hearted Board of Water Trustees tendered us our first annual banquet at the Neil House. It is very doubtful if the organization has since participated in a banquet where eloquence, wit and genuine hospitality played so prominent a part. It was here that the pleasant social features of our annual gatherings, which have since played so prominent a part in our meeting and helped to lighten the routine work of our convention, had its origin. The next annual meeting was held at Buffalo, New York, May 15th, 16th and 17th, 1883, with Colonel Foster still President and Mr. Decker, Secretary. A noticable increase in the membership was observed at this meeting. It is unnecessary to dwell at length upon the business features of this and each succeeding meeting. From a persual of the papers read as published in the reports and discussions thereon, the members must become impressed with the ability of the authors and the intelligence and practicability of the remarks of those who participated in the discussion. The pleasant feature of this meeting was the trip to Lockport and Niagara Falls. It was on this excursion that some of our members met with peculiar experiences. Niagara Falls, with her wonderful sights and still

more wonderful hackmen has furnished almost all sorts of subjects for authors, but it has remained for one of the members of this Association who is still with us and vouches for its correctness to first bring to light the following.

During the excursion of this Association to Niagara Falls in 1883, one of the members who is somewhat given to absentmindedness became fairly dazed in his determination to see the Falls in all its magnificence. With that object in view he hired a hack in the morning and was driven to the Canada side to see the objects of interest there. Arriving on British soil he left the hack and after viewing the surrounding sights for some time, descended the bank and went under the falls, forgetting all about the hack, and particularly the hackman. After devoting considerable time to this and other sight seeing, purchasing a feather fan, a bow and arrow, some Indian beaded work and other light trash, he crossed to the American side in a boat used for ferrying visitors across the river, arriving just before night fall. At some time he had heard of custom officers, and no doubt on this occasion, expected to be taken into custody for smuggling. Approaching the top of the inclined railway he met a man whom he supposed was a customs officer, and deciding to make the best of it, went up to him boldly, saying, "Well, sir, do I owe you anything?" "I should think you did," the man replied. "I am the fellow you hired to drive you around this morning and I have been looking for you for several hours. You owe me just twenty dollars." Of course, Mr. Milner paid it, but kept the fact to himself until long after that meeting. It was on this excursion that our associate Cameron, of Memphis, met his friends Libbie and Katy and had his pleasant interviews with them renewing a former acquaintance of several years. At this meeting it became apparent that this Association, whose origin dated at St. Louis three years before and who during its infancy had not increased as rapidly as might be expected, was now a well developed child; realizing in its entirety all the anticipations of its projectors and displaying a future of prominence and usefulness in excess of their fondest anticipations. To refer in detail or even briefly to each succeeding meeting of this Association since the Buffalo gathering, would, it seems to me, tax the patience and good nature of the members present and be a waste of time which could be more profitably spent. Suffice it to say that each succeeding meeting showed an increased membership, an increased interest manifested by the members and an increased exhibition of intelligence and information in the papers read and the discussions engaged thereon. The following reminisence furnished the writer by a member of the Association may not be out of place in this paper.

Michael Donahue, of Davenport, and W. C. Stripe, of Keokuk, were both in attendance at Buffalo. Both will be remembered with great respect and kindness. Both have since passed beyond the vision of this world and are now sleeping the sleep of the just. With due respect to the deceased, it may be said that they were both peculiar and dogmatic in their manner of looking at things. I remember well walking along with Mr. Donahue from the International Hotel to Goat Island, where we got the best view of the falls, and how pleased he was to express his great admiration of the sights seen. He had traveled much and had seen most of the many beautiful falls of this and the other country, and for a long time had heard of the beautiful falls of Minnehaha. I think it was before there were any railroad facilities; at any rate, he had a

great time reaching the falls of Minnehaha, and was not only disappointed but greatly disgusted to think that he had been silly enough to go to so much inconvenience and expense to see so small a thing, so extravagantly advertised. Even in relating it, the old man's face would exhibit most thoroughly his entire disgust. It is queer how variously we see beauty unadorned. A few years after we had a meeting at Minneapolis, and visited the falls, had the usual photograph taken, and many of us filed it away to remind us of a pleasant time with joyous faces all around. Of the falls there is little to say, but the sail around lake Minnetonka was a joy forever. At Denver the Association experienced an impetus which is yet felt. A beautiful city, a hospitable, open-hearted people. They took one of our members in open daylight and open arms in this fashion. We were to have a drive around the city in splendid carriages, all drawn by white horses, a sight seldom witnessed even in the cultivated and luxurious east. The carriages were formed in line at the Albany Hotel, the members were being assigned to their respective places. Some one detained our good friend Decker in front of the hotel until the patrol wagon dashed up with two policemen, who were told, "There's your man," pointing to the immortal Decker. They took him up bodily, placed him in the wagon and drove rapidly, followed by the whole party to the city hall. Such a yell is seldom heard in any civilized town. Our friend was fined a nominal sum and was let go under promise that he would leave the town the next day, which he did and has never since gone back after his grip. It was at Mammoth cave last year that we had one of the most enjoyable occasions. Most of the party had gone into the cave, returning before nightfall. It was a beautiful night; the moon shining brightly, and the air fairly perfumed with the scent of violets and crab apple blossoms. After it had become to late to hunt for four leaved clovers, the crowd scattered about, some being initiated into the mysteries of Order 71, others dancing, while a few were seated on the veranda telling stories. Colonel Moore had killed a large snake that day and snake stories had become popular. It is surprising how interesting a real snake story is. Colonel Denman told one first. I cannot undertake to repeat it in detail, but it was like this.

"When I was a boy, away back of the wilds of the west side of New York City, —it was sometime before I found Mrs. Denman at the somewhat famous Sing Sing,—and before New York was as thickly settled as it is to-day, I was a great hand to fish from the docks along the river. Well, one day, I looked towards the Hoboken shore, and saw an immense snake coiling his tail around the flag staff of an old abandoned boat on the Jersey shore, apparently in the act of striking at me across the Hudson river. I called the attention of some laborers to the fact, and one of them happened to have a pitchfork. Well, sure enough, that snake made a lunge at us, swinging clear across the river. We gave him lee way and as soon as his head reached the shore, the man with the pitchfork pinned him to the dock, and to my knowledge that snake served for several years as a foot log across the river."

A story like this, coming from a man of such dignity of manner and character was received with expressions of astonishment from the little circle. Mrs. Denman blushed and admonished Mr. Denman not to tell that again, and especially never to refer to her as coming from Sing Sing. The other ladies present were, as I remember: Mrs. Ryle,

Mrs. Morgan, Mrs. Richards, Mrs. Brown, Mrs. Diven, Mrs. Thompson, and the Misses Hermany. They all enjoyed it. It was a good story for a real snake story.

Then came Col. Gardner, who said in his insinuating manner; that he had no doubt the story was true; and that the snake had come over with the Pilgrims when a little fellow and was lost in the hold of the vessel, which being abandoned, gave him a chance to grow. But, said he, "That is not such a big snake story after all." He then told this story.

"Once Dr. Paxton, some friends and myself were out hunting in Arkansas. We found no game, tramped over the hills of the Ozarks until were just simply tired out. Dr. Paxton seated himself on what he supposed to be a log, to take lunch. The rest of us lay down to take a rest and were soon asleep. Paxton lunched away and did not notice that he was traveling along at the same time. Finally he became suspicous that something was wrong, and walked toward the butt end of the log, about one thousand feet from where he had been sitting, where to his surprise he found the head of an immense snake. He retraced his steps and the tail was just passing the spot where we were asleep. An alarm was sounded; the monster appeared to be harmless but all the time on the move. He measured from tip to tip a little more than 2640 feet. Supposed to have escaped from some menagerie and was growing up with the country."

"Great Cæsar's ghost, what are you dreaming about Brown?"

Brown, who had been quiet, seemed to be studying how long he had to be, to be 2640 feet long and mentally figured it out as just half a mile. Brown then took his turn like this:

"When Wilson's raid left Montgomery for Columbus, Ga., we passed through a country full of wild game of all sorts. One night we camped not far from Tuskegee, and a party of us went out early to hunt some turkeys. An old darkey went along to show us where they "mostly roosted." Just at the break of day I discovered a covey of eight or ten all on one limb. I had only one rifle and thought it a pity to kill only one, so after studying the situation over for some time, it came like an inspiration to me that I could secure them all. Very cautiously I crept under the tree, my intention being to split the limb with a Winchester bullet, and let their legs fall into the split, and thus the snap together of the timber would secure the whole bunch. I did so, and my recollection now is, after twenty-five years that when we cut the tree down, we had eight as fine turkeys as any one would wish to see. You bet the boys enjoyed their next meal. I have never had another opportunity to try this and have never heard of any one else doing it."

"Why don't you patent the device?" queried Col. Briggs, which showed the impression made on his mind.

Briggs said that reminded him of a story. In Indiana once, during the time Daniel Boone was hunting in Kentucky, he, Briggs, was hunting in Indiana, but coons was his specialty. One night the dog treed. When we came up with the torches and such like, we found a tremendously big tree without a limb on it. From the bark of the dog I knew the coons were about, but certainly not on that tree. Just as we were about to go away in disappointed disgust, I happened to notice a

slit in the tree which seemed to open and close at regular intervals, as far up as I could see. It opened fully an inch at every interval and I put my ear to the split and heard breathing. Yes, as sure as you sit here in the moonlight, that tree was plum full of coons and all breathed at once, which accounted for the opening and closing in the tree. Well we cut the tree down, and how many coons do you suppose we caught? My recollection is now, after forty-five years, that there just 2640.

By this time Order 71, had closed, the dance hall was filled, one by one the ladies had retired, and few were left to hear the remaining stories of another age. The moon shone brightly, the night was incomparably beautiful. Finally all was quiet and every one dreaming of snakes, turkeys and coons, and the long route they were to take the following morning.

At Boston, the members during recess, would gather in the parlors and on the verandas of Young's Hotel. The conversation then seemed to run in the line of curious things in art and nature. Col. Bull gave a graphic description of the catacombs of Rome, as seen and explored by him at the time of his last visit to that historic city. All this was listened to with unusual attention until Mr. Darling asserted that the same kind of catacombs existed under Pawtucket. He had discovered this similarity while excavating for a pump station. True, there was no grand arched galleries, no tombs, no papal crypts, bishops' chairs nor Appian ways, frescoed ceilings nor religious paintings; but in many other respects they were quite similar. Mr. Priddy seemed to doubt this. He had seen petrified forests in Colorado, which were more wonderful than anything ever heard of in Rhode Island, and entertained us quite a while with the description of the remains of a petrified giant found in Colorado a few years since, known as the "Solid Muldoon." Mr. Priddy thought this Muldoon must have been at one time one of the Aztecs of Mexico, who strayed up there to grow up with the country, died there and became petrified. He said it was a well-known fact that the Aztecs were a race of giants in the days of the discovery of America by Columbus, and disputed his right to navigate the Mississippi river. Major Henion, of Minneapolis, and Mr. Kelly, of New York, agreed with Mr. Priddy, while Messrs. Ayers and Diven thought Mr. Darling's experience was worth considering.

It may be remembered by all that several years ago Congress made an effort to restore to the southern states the battle flags captured during the rebellion, so called, so as to rid the department of the old, cumbersome and decaying relics. Fairchild made a great row about it, waved the "bloody shirt" and prevailed upon the President to veto the bill. About this time Mr. Richards had a dream which he related, as he says, for the first time at the Boston meeting. "I had eaten very heartily of possum, sweet potatoes and persimmon beer," said he, "slept heavily and dreamed that I was dead and was approaching St. Peter's gate. A great crowd was around that immense and liberally carved front entrance and I began to understand that I ought to have some credentials, but found upon examination nothing but a letter from the *Chicago Herald*. It occurred to me that I was not very well equipped for an entrance through the pearly gates, but having nothing better, I boldly approached. The crowd gave way and the sentinel demanded my credentials. When read aloud, my letter from the *Chicago Herald* made the crowd fairly go into

hysterics, at the "gaul" (as they called it) this manifested. Well, strange as it may appear, I was admitted. (I afterward found out that the reason of my prompt admission was that Chicago had been enterprising enough to remove old Libby Prison from Richmond and the old John Brown fort from Harper's Ferry, and re-erect and preserve these relics of the late alleged rebellion.)

However, once inside the limits, I looked cautiously around fairly bewildered. Everything was blue and every man had on the regulation uniform of the U. S. army. A guide was placed at my disposal and I proceeded on a tour of expectant investigation. There were squads here and there variously occupied. Some playing lawn tennis, some cleaning muskets and some playing foot ball with rebel skulls. It all struck me as very extraordinary. My guide carried me along the beautifully terraced walks, passing fountains of crystal pure water and velvet trimmed lawns. I did not discover any place with the familiar sign board, "Keep Off the Grass," and wondered all the more. Suddenly we approached a large stockade, but could not see over the fence, but could distinctly discern the clash of arms, the booming of cannon and deadly combat. I was greatly perplexed and started to retreat, but the guide assured me that there was no danger, that the boys were having a daily sham battle, just fighting some of the old fights over, blank cartridges and all that. Upon inquiry I found that there were certain days for certain battles, that this particular one was the siege of Petersburg. I asked if they ever repeated the first battle of Manassas, Chickamauga, Chancellorsville, etc., but he thought not; the names were unfamiliar. We wandered back to the entrance. Bewildered all the time, I could not realize that I was really in heaven, so turning to the guide I put the question flat, "Is this heaven?" "Yes," he said, "this is the G. A. R. heaven, but St. Peter has a little annex over yonder. Grant is there, and Lincoln, and Lee, and Stonewall Jackson and many others. Grant used to be here, but he kept on saying 'Let us have peace,' and so we fired him out."

And Major Jones is a very truthful and reliable man.

From the little gathering in St. Louis ten years ago, when the nucleus of the American Water Works Association met to organize, we have seen our society increase steadily with each increasing year until now we have among our active members more than two hundred and fifty persons. What shall I say of the merits of the Association, of the good it has accomplished and the benefits which have been derived from it?

Where shall I begin, or where shall I end? When so fruitful a subject to write upon is presented, one hardly knows where to begin or where to stop. Not only have our members who met annually and listened to the ably prepared papers read at these gatherings, received the benefits of these practical subjects, but they have been instructed also in an incalculable degree by the intelligent discussions indulged in after the reading of such papers. They have received and profited by the combined wisdom and intelligence of these gatherings and been able to make practical application of the many points discussed.

These papers and discussions have not been the idle vaporings of a lot of men gathered together to have a good time socially, but they have been the intelligent productions of men learned in the subjects under consideration and who have devoted their life labors in the pursuits on which they have written and spoken. We number among our members men who are engaged in the manufacturing of water works supplies of

every conceivable style and device, men who have devoted their best energies for years to the management and practical workings of water works plants, and men who have thoroughly familiarized themselves with the wants and necessities of the communities in which they live; and each of these persons has devoted his best abilities toward instructing his fellow members and all other persons interested in water works construction and management by faithfully following the standard of our society. Were there no other meritorious consideration expressed by me of this Association, than the bare fact that our members have looked forward to our annual gatherings to obtain a solution of some knotty question which has arisen in their business during the preceding year, and in each case invariably found an easy explanation of their difficulty, enough would be said to commend the Association to all whose employment brings them into contact with the manufacturers and managers of water works plants and machinery.

But this is only a single meritorious point of the Association. How many listening to this paper cannot recall some instance where an almost unsurmountable obstacle presented itself to them in their business and who at considerable loss of time and money have come to our annual gatherings, explained their trouble, listened to the combined intelligence of the assembled members, found the solution of their difficulty, returned to their employment and applied knowledge thus obtained and saved either themselves or their employers vast sums of money. Scarcely a meeting during the past ten years has occurred when just such cases as I have related have not come up, and neither you nor I can conceive, nor is language strong enough to express the benefits which have been derived from the intelligent discussions of these questions at these meetings, and the application of these important truths impressed upon all who have taken part in or listened to them. A good wholesome supply of water is as necessary to a community as the air that is breathed. The amount of capital invested throughout the United States in an attempt to accomplish that end is almost incomprehensible. We speak lightly in general conversation of the different plants in different localities, but if we stop for a moment and attempt to calculate the vast sums thus invested by private investors and municipalities we will realize at once that we have undertaken a herculean task and that the sum is almost inconceivable and yet this Association, gentlemen, is the only one in the United States having for its object the proper protection of this vast investment, and at the same time the proper protection of the consumers. How many instances can each person here recall of solutions given by this Association of how to procure supplies of wholesome water for different localities? How many instances can each person here recall of solutions furnished by this Association of how investors—private and municipal—could secure a reasonable return for their investment without imposing any hardship upon the consumers? How many instances can each person here recall of the price of water to consumers being reduced in addition to the supply being more wholesome by reason of the application of truths learned at our gatherings? You may take any large corporation in the country, notably our railroad corporations, and they have their regular meetings, not annual by any means, but almost weekly; and the constant study of those meetings has been and is to devise some means whereby the corporations they represent may become more powerful—how a dollar expense may be reduced here, a dollar there, and how the income of the

corporation may be increased in this point and in that, and how combinations may be made to advance the general business prosperity of their companies. With us it is different, as you all well know. While the rights and interests of the investors are carefully guarded and all legitimate protection is sought to be given them, at the same time the rights of the consumers are vigilantly watched, and as much time is devoted by this Association toward their wants and necessities and the most feasible and cheapest method of supplying them as is given to protecting the rights of the invested capital. The best mechanical minds of the country are constantly employed devising means of supplying water in the most economical way, and through the combined wisdom and intelligence of our members the application of these devices is made for the benefit of the consumers. This subject might be continued *ad infinitum*. As was stated in entering on this subject, one hardly knows where to commence nor where to end, but the length of this paper warns me it is time to come to a conclusion. I have endeavored thus briefly and as concisely as possible to call your attention to what has been accomplished in the past ten years. Who of our present membership will live to relate the achievements of our Association in the decade to come? If the next ten years of our existence prove to be as fruitful of progress and advancement in the accomplishment of the objects for which we are banded together as the past ten years have been, I predict that the work of the historian at your twentieth annual meeting will be more extensive and laborious than any of you now realize. Then, if we are to judge the future by the past, it would be useless for me to attempt to discuss, or even guess at what the benefits and advantages will be that the private investor, the municipal corporation and the consumer will alike receive from your combined wisdom and intelligence. Leave that task to some future historian. Follow the plans already mapped out and pursued and you will draw around you the best talent and most scientific minds of the country, together with the support and recognition from the owners of water works plants throughout the country. I trust it may be my privilege and pleasure to listen to the historian who at the twentieth annual gathering of this Association will relate "The merits of the Association and the work accomplished in the past ten years." P. H. Linneen.

The President: As there seems to be no discussion on the paper just read by Mr. Linneen, we will hear Mr. Tubbs' paper.

THE BASIS ON WHICH SCHEDULES OF WATER RATES SHOULD BE DETERMINED.

BY J. NELSON TUBBS.

It is a well understood fact that schedules of water rates for cities and towns in which water has just been introduced are usually established on the basis of the charges in other cities and towns of like population, where the works have been in operation for a considerable period, and not as the result of a detailed study of the elements of cost of construction and maintenance, and probable revenue.

A little reflection will satisfy anyone that the usual plan is unphilosophical, and is simply guess-work.

Whether the works are constructed and owned by a municipality or by a private company, the general rule remains the same, that in some way the works must be made to pay, otherwise the original and consequent continued investment would not be made.

It is further true that the conditions as to source of supply, length of conduit, quality of soil and required size and length of distribution pipes, are not alike in any two towns, and therefore the cost of construction and maintenance must necessarily be unlike, and as a consequence the schedule of water rates must differ for each town, provided they are fair and equitable alike to the owner and consumer.

Assuming the correctness of the foregoing premises, the conclusion must follow, that some more rational method than the *rule of thumb* should be adopted to determine an approximately correct and equitable schedule of water rates for each case.

I therefore respectfully submit to this Association, for the consideration and criticism of its members, the following method for such determination.

(1.) Determine the sum represented by the original cost of the works compounded at four per cent. per annum for twenty years.

(2.) Determine the sum represented by the estimated yearly cost of operating expenses and repairs, each said yearly sum compounded at four per cent. for its proper number of years, from twenty to one.

(3.) Determine the sum represented by the estimated yearly cost of extensions of the pipe distribution, each said yearly sum compounded at four per cent. for its proper number of years from twenty to one.

(4.) Determine the sum of money which at the end of twenty years will represent the cost of metering each service as it is put in including interest, repairs and depreciation, the life of a meter being taken at twelve years.

The sum of the four preceding items will represent approximately the total cost of the works at the end of twenty years, including compound interest at four per cent. on each item of expenditure from the time it accrued to the end of the twenty year period.

(5.) From the sum thus obtained deduct the estimated yearly hydrant rentals to be received for twenty years, each year's rental being compounded at four per cent. for the number of years from date of receipt to end of twenty years. The determination of yearly hydrant rental to be made in accordance with the method suggested in a paper read by me before this Association, at its meeting in Cleveland two years ago.

The resultant difference will represent the amount of expenditures made, together with accumulated interest for a period of twenty years, which said amount must be paid out of the receipts of water sold.

The amount of water sold in twenty years is approximately determined by the following described method :

In these days it is not difficult for the hydraulic engineer who designs and constructs a system of water works to determine, with substantial accuracy, its capacity in gallons per day, either by the application and solution of a proper hydraulic formula, or by actual measurement. From the capacity thus determined, my experience would lead me to deduct twenty per cent. of the whole supply as a reasonable estimate for loss by evaporation from reservoirs, from undiscovered underground

leaks, from the use of water for the suppression of fires, from the wilful or malicious waste of water from unmetered fixtures, and from the imperfection of meters or other registers, used in measuring the water supplied to consumers. There will thus remain only eighty per cent. of the total supply from which a return in water rents is made to the owner.

As it is usual to plan works with the design that they shall furnish a sufficient supply of water for a growing town for a period of at least twenty years, and we may assume that at the end of that period the water will be all used and paid for in rates. For the purpose of an approximate calculation we may also assume that one-twentieth of the whole amount will be sold the first year, two-twentieths the second and so on in like proportion for the remaining years. On this assumption it is not difficult to determine the total number of gallons of water which will have been sold at the end of twenty years.

(6.) If the total expenditures at the end of twenty years, less the total hydrant rental, be divided by the total amount of water sold, we shall have as a result the *rate* at which the water must be sold to balance the account at the end of twenty years.

Apparently, by this process, the owner of the works will at the end of twenty years, have received back all money previously expended by him in the construction and operation of the works, together with four per cent. compound interest thereon. There is, however, one fallacy in the process, and it consists in the fact that no allowance of interest is made on the receipts for water sold year by year during the twenty years. The amount of this interest may, however, now be determined, as the amount sold each year and the price charged for the same are known, the compound interest on each of said yearly amounts for their respective periods up to twenty years is easily determined ; and when determined, it will be treated as a percentage of profit to the owner, to be added to the four per cent. previously allowed for the use of his money.

While it is claimed for this method that it will determine with approximate accuracy the price to be charged per 1,000 gallons in any given case, where the water is measured by meter, yet as in some cases it may not be practicable or convenient to apply a meter, it therefore becomes necessary to prepare a schedule of fixed rates for special uses of water.

As such a schedule must be based on the rate charged per 1,000 gallons, it is not especially difficult for the experienced water works manager to convert each special use into gallons per day, which multiplied by the rate per gallon, or 1,000 gallons, will determine the fixed rate to be charged for the special use.

That the foregoing method may be more clearly understood, I proceed to illustrate by a purely imaginary case, as follows ;

Suppose a system of water works is just completed in a growing town under the following conditions :

The present population is 4,000; the rate of increase is estimated at 250 per year, the capacity of the works is one and one-half million gallons per day, the original cost is $100,000; the estimated yearly cost of repairs and operating is $8,000; the yearly cost of pipe extensions is estimated at $4,000; the number of hydrants at first set is seventy, and they are estimated to increase at the rate of ten each year for twenty years; that 100 services and 100 meters for same are put in each year for twenty years, when it is expected the capacity of the works will be reached and the yearly rental of each hydrant will be, as determined by

my method, $35. Under these conditions, what should be the rate charged per 1,000 gallons for use of water?

SOLUTION.

$100,000 at compound interest for twenty years at four per cent.	$219,000 00	
$8,000 yearly repairs and operating expenses each said yearly sum compounded at four per cent. from the date it accrued, until expiration of twenty years	247,760 00	
$4,000 yearly expenditure for pipe extensions, compounded as in last preceeding item	123,880 00	
$3—Being the sum necessary to be placed yearly at compound interest at four per cent. for each meter, and which will pay yearly interest, $0.95, yearly depreciation, $1.30, and yearly repairs, $0.75, and renew the meter each twelve years; the process being carried on for twenty years until all services are metered	85,403 00	
Total		$676,043 00
DEDUCT FROM SAID SUM.		
$35, the determined yearly rental value of each hydrant, at compound interest at four per cent. from the time it accrued to the end of twenty years		158,429 00
Balance to be made up from water rents		$517,614 00

It now becomes necessary to determine the total amount of water sold during the twenty years. We have assumed that the total amount of supply is one and one-half million gallons per day, and that eighty per cent., or 1,200,000 gallons per day, or 438,000,000 gallons per year, is available for revenue. We have also assumed that one-twentieth of this amount, or 21,900,000 gallons, is sold the first year, two-twentieths the second year, and so on to the end of twenty years. A summation of these yearly sales in the case in hand shows the total amount sold to be 4,599,000,000 gallons.

If we now divide the $517,614 which is to be paid by the sale of water by the 4,599,000,000 gallons sold at the end of the period, we find that the price per 1,000 gallons must be eleven and one-fourth cents.

As heretofore stated, the only fallacy in this method is the fact that no interest has been allowed on these sales from the date of sale to the end of the period of twenty years.

Applying the price of eleven and one-fourth cents to the quantities of water sold yearly, and determining the compound interest at four per cent. on these several amounts for their proper periods, we find that it would add one and one-third per cent. yearly to the income of the works up to the end of twenty years, or give the owner a yearly return from his investment for the first twenty years, of five and one-third per cent.

It will be readily seen that at the end of twenty years, all the money previously expended on the system with five and one-third per

cent. interest added will have been paid and that from thence onward the percentage of receipts over expenditures will be very large or in other words that the works will pay a very large percentage on the yearly investment and will be very profitable, and the rates may, soon after the end of the twenty-year period be materially reduced.

In mitigation of this reduction of the rates, may be named the necessity of renewing the pumping engines and boilers in case of a pumping plant, and more or less expensive changes in the pipe distribution, and the renewal of parts of the same and of the fire hydrants.

I have fixed the period of summation and balancing of expenditures at twenty years for the following reasons :

(1.) That under the interpretation of the laws of the state of New York at least, all municipalities borrowing money for the construction of water works are required to provide a sinking fund, which with the accumulated interest shall at the end of twenty years pay the amount thus borrowed.

(2.) That works are usually designed for furnishing a supply sufficient for a growing town for a period of twenty years.

(3.) That it is questionable whether in the average of cases it is prudent or profitable to make such an expenditure as would provide a supply for a period exceeding twenty years.

(4.) It is questionable, whether capitalists with a full knowledge of the facts, would be willing to wait longer than a period of twenty years for a determination of the question whether the investment made is to be a financial success.

(5.) In cases where the construction of works involves the use of pumping engines, boilers and stand pipes, large expenditures are liable to be necessary on the renewal of the same within or at the end of twenty years.

(6.) The exact financial standing of a company with a large investment of capital should be capable of determination at the end of a period of twenty years, to enable its securities to have a merchantable value.

The uniform use of four per cent. interest in the foregoing method is based on the fact that it is the percentage paid to depositors by Savings Bank institutions.

The necessary expenditure of applying a meter to each service, is based upon the following reasoning :

The only fair and equitable way in which to sell water is by measure, as in the case of other merchantable commodities, and the corporation offering it for sale should furnish such measure, and when thus furnished it becomes a part of its stock in trade as much as any other part of its plant, the expenditure for which should be reimbursed by the consumer, in the rates paid by the consumer for the uses of water and for the same reason that the merchant charges such a percentage of profit in the sale of his goods as will reimburse him for the rental of his store, and for the supply of scales or other measures for the goods sold.

I therefore assume for the purposes of this discussion that every water service should be metered, that the meter should be regarded as an integral part of the water works plant, and that the user of water should contribute in yearly rates such sum as will remunerate the owner of the works for procuring and maintaining said meters.

While absolute correctness is not claimed for the foregoing method,

yet it is claimed by the writer, that it furnishes a simple, logical and approximately correct method by which a company or a municipality may determine upon a rational and equitable schedule of water rates from the beginning, so that on one hand the work shall pay as an investment, and on the other hand that the consumer shall not be overcharged and oppressed by excessive charges for water.

The method is simple enough for popular use, and accurate enough to determine a successful business venture. The method is equally applicable for use in the case of municipalities, as well as in that of private corporations, except in the case of the latter; another element will have to be introduced in the determination of total expenditure at the end of twenty years, and that is the item of yearly taxation, which is to be treated in precisely similar manner as the yearly cost of repairs and operation, and which will of course increase the amount of total expenditure, and also the rate to be charged per 1,000 gallons for use of water.

Mr. Diven: If Mr. Tubbs' theory can be carried out I think it is a little better than most water works are doing. At the end of twenty years on his plan, we have got a plant that is worth $220,000, that has not cost us a cent. But, let us see if that theory will hold—say at the end of twenty years our population is 9,000. Now, that is at the rate of one tap for every four and a half of the population. It strikes me that it is rather above the average. We have got 270 hydrants at $35.00 each, or $9,450.00 that the town pays for fire protection, which would be a little more than a dollar each for every inhabitant. That is pretty high. Eleven and one-fourth cents per 1,000 gallons sounds pretty low for water, but figure at that price and allowing twenty per cent for leaks, fires, etc., it gives us ninety dollars per 1,000,000 gallons, for all water pumped, which is certainly a paying price.

Mr. Sawyer: It seems to me the gentleman has left out a very important element. Fifty per cent. of our plant is represented in reservoir. Circumstances may occur by which the whole thing is swept out, and there is nothing which you can fall back upon. A private company must have a revenue to cover all contingences. It is different when a municipality owns the works. They can arrange it by tax. I have regarded the establishment of some uniform rate as Mr. Tubbs has said, as one of the most important works that could be accomplished by this Association. I have books from the various water companies containing their rates. I find that my neighbor is charging $8 for a certain

service which is on our book 84, and he charges 84 for another service which is on our book 88.

Mr. Diven: Though I consider Mr. Tubbs' example rather rose colored, I thank him for his paper, and I wish the consumers could be brought to look on it in that light. I remember an instance of a man moving from Mr. Tubbs' city to the city in which I have charge of the Water Works. When he received his water bill he "kicked," claimed that the rates were excessive, they were higher than he paid in Rochester. My argument to the effect that the conditions were different made no impression on him ; he couldn't or wouldn't understand why he should pay more for the same service in one city than in another.

Mr. Milne: I observe on the last page of his paper, Mr. Tubbs make the statement, "The only fair and equitable way in which to sell water is by measure." That involves a consideration of the whole question, and it is widely different in its operation whether it be a municipal water works or private corporation. Now I know in Providence how to administer safely, efficiently and profitably a water works administration. Municipalities have no financial consideration in the administration of water works. I mean particularly large water works, large municipal water works. It is an incidental question to a municipal corporation, whether there be a deficit at the end of the year pertaining to the water works administration. If there is, it is easily made up by the issue of bonds under the law, and so it goes from year to year, and as the city grows it is not a difficult thing to assume the bonds. Now, it is very different with a private corporation. It is not easy for them to bond their works from year to year to make up deficiencies. The question for them to consider is how shall we produce ways for reducing expenses. In short, you must not lose sight of the important factor of ten per cent for renewal of your works. Mr. Tubbs has said 12. I say ten is liberal. Eight years has qualified me in making positive the statement that the only equitable and effective mode of disposing of water is by meter measurement.

Mr. Denman: I wish to make a criticism in one

paragraph here. I think that his reasoning is illogical and not fair. He says: "The only fair and equitable way in which to sell water is by meter as in the case of other merchantable commodities." A man who sells water by meter is not be compared with a man who sells potatoes or molasses or any other merchantable goods, and the corporation selling it should furnish such measure. I object. When they have furnished it, it becomes a part of its stock in trade as much as any other part of its plant. That method of reasoning is quite wrong. The expenditure for that should be reimbursed by the consumer in the rates paid by the consumer; that is, suppose a consumer has a meter which cost $15.00 and uses only two or three dollars worth of water, where does the company derive its profit, or where are they to be reimbursed? It must be paid by the consumer who uses the water and for the same reasons that the merchant charges such a per cent on the sale of his goods as will reimburse him for the rent of his store and the use of his scales. Now, I think if the grocery man had to furnish a peck measure for each one of his customers that he would have to raise the price of his goods considerably. He uses one for all of his customers. He is present when the person takes the goods but the water company has to furnish a measure for each customer, no matter how small the consumption of water, and is never present when the water is sold. I think you recognize the distinction and the question has been recognized by the courts wherever this question has been raised that it is the duty of the consumer himself to furnish the meter. I think when a consumer requires a special measure for his own use that he ought to pay for it.

Mr. Darling: I agree with my friend Tubbs in the mater of selling water by the measure. I agree that the meter ought to be a part and parcel of the construction account. I believe it because I have had a practical experience of ten years in that system. I believe our city introduced that system first, and I don't know but it stands to-day almost the only one in the United States where we furnish the meter to the consumer free of any cost to him, and charge it to construction account, and from the practical experience we have received, I

believe it is the only plan to adopt. I believe that if I was an incorporator of a company selling water to any city or town that I would recommend the company to furnish meters for every consumer. You ask where we gain by a consumer that does not use but one or two dollars worth of water a year. We gain it in the pumping of the water. We don't have to have as large a pumping engine. I claim to-day that under the rule of taps that the tap consumes twice the amount of water that the same service would use if metered, and therefore requires, twice the amount of pumping capacity. I claim that we have saved by the introduction of $30,000 worth of meters $60,000 in the cost of our pumping plant, and that we save one half on the continual running of the same. I believe I can show it to any gentleman who wants to visit the works and see it practically illustrated. I further disagree, perhaps, with the gentleman who claims that a price can be formulated that will be adaptable to any situation that might be called for. I cannot see that that should follow because I believe circumstances will vary in diffent cases. I know cities and towns that make large appropriations for maintenance account and I say you have got to adapt this to the situation required. If you go into a city and put in water works you have got to receive, if you are a private corporation, a compensation sufficiently large to pay you for the cost. I cannot see how you can formulate a price which can be universally adopted which would govern all cases.

Mr. Tubbs: I should be very glad to reply to several gentlemen who have so kindly discussed and criticised the paper, but as this question of meters is coming up in a different shape this afternoon, I suggest that under the circumstances this discussion had better rest here until the papers are read and then they can both be discussed together.

Mr. Campbell: I just want to notice one remark Mr. Darling made, that he thought very few water works were self-sustaining. I think it is just the reverse, that all private water companies are self-sustaining because they are managed on strictly business principles, and I take issue on the proposition that generally meters

should be used. I say for manufactories, breweries and for houses that are occupied by tenants that a meter is a good thing, but whenever you put a meter upon a private house you make a mistake.

THE PRESIDENT: Before adjourning I will, according to custom, appoint a committee on nomination of officers and name the following gentlemen as such committee: Peter Milne, J. Nelson Tubbs, H. W. Ayres, Wm. Ryle and J. T. Lakin.

On motion adjourned.

AFTERNOON SESSION.

Meeting called to order by President at 2:30 p. m.

THE PRESIDENT: The first order of business is a paper by Mr. C. Monjeau.

A FEW SIMPLE SUGGESTIONS AS TO WATER AND WATER SUPPLIES.

BY C. MONJEAU.

"Water" dignifies the name of this institution, and places its purpose among the most useful and praiseworthy of all that ever engaged human energy and intellect.

There is no boon like a sufficient supply of pure water. Wine, women and wealth have been lauded to the echo by gifted men of all ages. The sweetest of songs, the loftiest strains of eloquence, and the greatest outbursts of genius in all known arts and pursuits owe their immortality to this swayful trinity. Mighty indeed is wine. Mightier is woman. Mightiest is wealth. But well nigh omnipotent is water. It likely constitutes ninety per cent of the globe and its innumerable species and kinds of teeming life. It is the essential of essentials. Yet, it is esteemed and craved less than money; less than raiment; less even than obedience to the dictates of fleeting fashions.

This indicates a social disease. It should be cured. To this end we should direct a goodly share of our energy. For in all the realms of human knowledge there seems to exist nothing more useful and desirable than pure water. Money power, kingly rule, well balanced brain development, culture of intellect, grace of form, speech, love of the beautiful, God-like magnetism of leadership, and profound spiritual insight are either gifts or acquirements greatly to be desired. But none of them all, nor all of them approach in desirableness a liberal supply of pure water. For water is, at least, the medium of life. It may also be made the vehicle of death. It often has been. What more it is no science has demonstrated. But there appears to be cause for indulgence of many

conjectures, and even toward such as incline to look upon water as the resort of the spirits of their dead.

Certain it is that pure water is the chief necessity of health, as of life, and that life without health, no matter what other gifts or choice acquirements may accompany it, is an ungrateful burden. Hence, it were difficult to overestimate the value of pure water, or the services of such as devote their time and energy to its procurement for the benefit of their fellow-beings.

It is granted that to seek and struggle for those things which are most helpful to man and beast is the highest aim of truest manhood and womanhood. Now, if for this reason, law making and law interpreting be considered honorable; if bravery in battle be long and loudly lauded; if ministering to the moral and religious sentiment or element in man, and to the health of limbs and life be exalted in public esteem, then what honor ought not he to deserve who devotes all his powers to procure and serve the fluid without which not a known form of life can begin or develop? Without which not a single sense can exercise healthy function—aye, without which our proud land of teeming beauty, thrift and might were a waste; our new prosperous cities but dreary tombs; the great countries of the earth vast cemeteries, and the globe itself a grave?

As a rule, the honors conferred upon workers in a given calling are in proportion to the need and use of such calling. And it seems well and just to have it so. Have you, then, any reason to neglect the study of the sciences bearing on your calling? Or to be ashamed of it in any regard? Or not to yearn and work to see it respected as is no other calling? A reward which it richly deserves.

In this connection it is not deemed necessary to state in detail what tremendous responsibility rests upon you as water works men. It may suffice to say that the health of the people, the most valued of life's innumerable possessions, is in your keeping. Yea, their very lives are more completely in your hands than they possibly can be in the hands of any other class or classes of men. Hence, I trust you will here permit me to digress in a few words which much of nerve taxing experience makes me yearn for power to hurl into your minds with the piercing glare of lightning and the impressiveness of thunder.

Your temptations not to be thoroughly loyal to your trust are great. Water works bond holders want full interest. Stockholders dividends. Private owners run water works for returns. City Councilmen are often better qualified to handle the tools of a railway section gang under a boss than to have in charge the interest that most concerns the health and lives of a prosperous and happy, but, in a degree, helpless community. And capital, greed of rapid gain, and ignorance bordering on the brutal at times, are apt to exact of you much else than loyal duty to your great trust. When the claims of such superiors clash with your manhood and your sense of duty to the health and life of your community, dare to be heroes! No soldier, no idol of public admiration ever battled or suffered for a worthier cause than the health and lives of a trusting, confiding community.

Of all monuments on the planet the most effective and helpful I know is that unpretending bronze figure of General Steinmetz, standing in a public square not far from the late Berlin residence of Prince Bismark. That monument was erected in commemoration of a speech of one word thrice repeated. Once upon a time, so the story runs, being

sorely and persistently tempted to betray the confidence of his king, Steinmetz, who seldom uttered a word, simply but resolutely answered, "Never! Never!! Never!!!" May his course prove a model for yours and mine under similar trials in the discharge of duty to our calling.

As suppliers of water the health and lives of your respective communities are, to a very great extent, in your keeping. Hence, you are liable to sins of omission as of commission. For instance, neglect to inform yourselves as thoroughly as practicable, and to see that your water supplies are securely protected from dangerous pollution, would and should place you in the attitude of criminals before the community whose charge or confidence you would thereby betray. Therefore, whilst replete with honor in the event of your faithfulness, your task is likewise crowded with risks of the gravest kind in the event you fail to prove equal to every emergency.

No calling needs keener culture and more continued study of broadening and deepening sciences than does yours. It has been held that the water works man should know how to fire a boiler, run a pump, locate a hydrant, set gate valves and collect dues. These are but the A B C's of his calling. To-day he cannot do his full duty towards public health without he follows closely such lights as Pasteur, Chamberlain, Vidal, Chantemesse, Brourardel and the leading experts in Chemistry on his own continent.

The remedy for the chief defect in our century's civilization must be looked for in your calling. It is left with you, and to you, to cut and cull and appropriate from all branches of learning the data you need to guide you in useful, practical experiments. Don't delude yourselves by waiting for the help of "Eminent Professors." They seem all to be employed fully—home stock and importations alike. The American fever (as foreign scholars term our inordinate love of wealth) has taken so firm a hold upon the country that, so far, we can boast of but one Agassiz. He seems to have been the only American genius who could resist the temptation of using his great intellect as the motive-power of a money-making machine. But the fact that he now sleeps under a granite boulder from his native Alps may suggest why, when offered vast sums of money for the writing of text books, which his fame would readily sell, he promptly answered: "I have no time to make money." Being not born in the miasma of our National epidemic, the tissue of his brain did not sufficiently soften and relax for the germ of our disease to find lodgment.—Before dismissing this branch of our subject, it should be repeated that, as members of a calling needing the free and constant exercise of the broadest intelligence and culture attainable, we must develop more self-reliance by depending more upon our own exertions, research and experiments. The task is by no means a light one to assume. It involves the more or less complete solution of many problems propounded by the philosophers of every age since the beginning of historic records, and that still remain unsolved. For example, among the first questions for us to answer are these:

(1). What is life? which needs about 90 per cent of pure water to thrive on, and yet cannot with impunity incorporate impure water.

(2). What is death? and what the nature of its means of warring against life?

(3). What are the respective effects of the different kinds of water upon human and domestic animal life? This question alone involves a

multitude of others, and is one of the greatest importance, morally, religiously, socially and financially, as well as medically. Hence, we can feel at liberty to ask farmers, physicists, physicians, states, cities and capitalists to help us in arriving at its many-sided solution.

(4). How shall we continue to procure and serve pure water, when all other industries than ours, despite law, and spreading disease in many instances, seem to conspire with the rapid increase of population to infect with disease germs all our streams, lakes, springs, and much of the territory that bears ground water? But, enough. Scores upon scores of other cognate queries crowd together with these upon us, and urgently exact intelligent and speedy solution.

To the first question, namely, what is life? I could not pretend to offer any but the most elementary answer, and that, too, with unfeigned consciousness of your right to remind me that "Fools oft boldly leap where angels fear to tread." But we are forced to the wall. We must batter or bore through. Archimedes might have lifted the globe out of its orbit had he but had a fulcrum. If we are going to lift one another to the lofty plain of our great duty to humanity, we must have a place to stand on and pry from. So far no one has built such a place for us. We have no alternative but to build for ourselves. True, our science is naturally interlinked with all others, and can derive light and help from all others, as can all others from ours. But the task of its development remains for us to take up and carry to the very front of all human achievements.

And it seems to me that the first duty of this growing National and Inter-national institution is to impress upon the whole people of America the fact that, in order to be and remain possessed of healthful, vigorous, useful life they *must* use pure water. For,

First.—Judging from the manner in which being in every form clings to life, it appears safe to assume that that inscrutable gift is the most precious of all from nature.

Second.—It appears that, subjectively and objectively, strong, healthful life is the most cherished and effective. Hence,

Third.—It seems to appear that, having life, health becomes the most desirable and valuable of all earthly possessions.

And that health is such, all efforts in civilization, towards civilization, and for civilization positively assert.

So do all efforts at legislation, and the noblest impulses of love, labor, and sacred religion. Therefore,

Fourth.—It appears evident that to conserve life in fullest health is the first and foremost duty of intelligent man or men. This, pre-eminently, is the task and duty of suppliers of water to the people. It follows that it is pre-eminently the task and duty of this Association. And, therefore, it becomes our duty to endeavor to co-operate more closely with the American Public Health Association, by means of visiting committees and otherwise, and also with such other associations as are closely allied with ours in their objective purposes.

Among the first obstacles to overcome whilst persistently pursuing our lofty object, is popular inability to appreciate what is for the best. The average water committee of city councils knows almost nothing of the task it is elected or appointed to perform. For this no one blames such committee. The fault lies primarily in our unfortunate habit and principle of pushing everything into politics, even to the health and lives

of the people, and alloting the most vital interests to the best vote-getter, no matter what his other disqualifications may be. The results are more or less of a kind with the following samples, which are culled from among hundreds of similar ones, and here cited as practical illustrations and warnings, and not in the least with intent to reflect upon any individual or locality.

The average town after deciding to have water works, usually appoints or elects what is known as a water committee, or water trustees. This committee is usually taken from among the council. You know how councils are elected. The members of the committee, as a rule, are totally unqualified for the task allotted them. I have known some to go and consult an electrician; others a machinist; others a railroad grader; and one—a trio of jolly good fellows from Indiana—to go and consult a milliner for a water supply.

The "lowest bidder" is the man who gets the license or the contract to supply the "dear people" with the prime essential of life and health. Of his qualifications the committee knows very little.

Actual cases in point.

Last year a goodly town in Indiana resolved to have water works. The "franchise" or "bond system" was decided upon. A Texas pony peddler proved the lucky bidder, but he could not raise the funds and the franchise lapsed. Within the past four months another franchise was awarded. This time to a man whose qualifications for such work I have not been able to ascertain any further than this. Upon asking a water works constructor of good standing and long experience, "Who is the successful bidder this time? Had I better write to him?" The answer I received points a moral. It was this: "*No!* Don't touch him. He's a penniless scrap iron speculator. This is his first job. He's a —— scoundrel!"

Another illustration in point I met with in Alabama. It was in a nice town of old southern style, just waking up amid the boom that rushed through that historic old state, and in the hands of energetic, able young business men. There alighted, fresh from the national metroplis, an exquisite of faultless attire. Even the famous Paris man milliner could not have turned a waist or curved a flank more elegantly and gracefully than this water works constructor on the franchise plan exhibited at this appearance. He was a picture to behold. In smoothness of speech he was unexcelled. In fact, it did seem as if Lord Chesterfield himself might have improved by a few points in his famous bearing had he but been permitted to look upon this, the Honorable Apollo Archimedes Crœsus from New York, in the act of addressing a lady. His card and letter head unmistakably indicated financial strength fully equal to supporting the tiny toed boots, much cloth, corset, English cane, Derby hat and cropped hair, which, as it afterwards transpired, constituted much over nine tenths of the firm's capital. He got the franchise and firmly established his claim upon the municipality by digging a ditch a hundred feet long and eighteen inches in width and depth, along the principal street. He ordered costly expert inspections made for water; contracted for a water supply; bought pumps and stand pipe, boilers and all other things necessary. But for all this he never paid a dollar. To be brief, upon careful investigation it was found that his qualifications as a water works constructor entitled him to a place in the foremost rank of confidence men, and his social status to state prison. The works which he

owned and operated at that time have not yet been built. Nevertheless, he duped at least four different councils in as many different states into granting his firm franchises. His best friends and three wives, I was informed last week, are now looking and longing for him.

Over in Texas another of these specially qualified constructors obtained a contract; got a water supply by draining a bog with driven wells, and everything worked to his heart's content until he was compelled to test his water supply as to quantity, though not as to quality, when Nemesis overtook him. His driven wells clogged up somewhat sooner than is usual, and he found it convenient to visit a relative in Canada. The city has since contracted with one or two other adepts of similar qualification, but, so far, it has not succeeded in securing anything more than experience for its money and the valuable time of its Solomons.

In the next state on the circle a council went up a hill and dug a large well in loam and sand right in the water shed of the town cemetery. They could and did dip up the water by hand whilst digging the well to the very bottom. But that was not sufficient warning. They walled the well and set two nice million pumps in it; roofed the whole; built a substantial boiler house and finished the works. Then they made the test. Their well was expected to yield at least 500,000 gallons per day, but they did well when the pumped 40,000. In pumping that much they drew all the neighboring wells dry, to say nothing of the vaults, the works were in a populated part of the city. The worthy parish priest whose residence was in the same square with the works, finding his well drained by the city pumps, went to taking water of the city, and converted his own well into a vault. But this successful bit of close economy did not last much more than a year. The graveyard and the private wells and vaults once drained, a drought set in, and the city had to look for a new supply. But the honorable council had been changed in the natural order of events, and the incoming wise men began, in turn, to gather experience by moving their works before making certain of a sufficient and sure water supply.

But turning eastward, where cleanliness should at least equal professed godliness, and where more care of health and life is expected than in the new states, we find the city of Brotherly love, where, it seems, love is so strong and enduring that they don't "eat up" but drink down one another. Only the other day a talented and practical Philadelphian said to me, "Actually, every time I drink I imagine I smell my grandfather." "How so?" I asked. "Why, I've seen the black stuff ooze from the graveyard into the Schuylkill so long that I can't help that queer sensation."

The liberal surface sewerage of the city and near suburbs, most of which empties into the scource of water supply, amply warrants this keen criticism on the part of the Carncross minstrels.

Two supposed escaped convicts, claiming to be former employes of the city, come clandestinely to ask the honorable commissioners for positions, which, it seems, can be granted only to citizens of Philadelphia. Various ways are tried to determine whether the two claimants of this honor are really genuine. All tests are successfully withstood till this, the supreme one. A glass of Schuylkill water is handed to each claimant with the request to drink it. The first one makes a desperate effort. He gags. Pulls from his glass a remnant of suspenders. Tries

again. Dips out a lizard. Again tries, and spurts out an indescribable compound, exclaiming that he can't stand that test if he dies instead. "He's a fraud."

The other as calmly swallows his as Captain Cameron would a glass of ———Memphis water. "Hurrah! he's a genuine citizen," all shout in chorus, "for none but a true Philadelphian can drink that."

Over the Delaware sits another city of equally brave inhabitants. They also pump direct from the river, which receives much of the sewerage of Philadelphia, the waste of a boat, barge and wharf population estimated at 100,000, and its own sewerage, together with that of Gloucester, Pavonia, and some ten more considerable towns.

In the cluster of cozy suburbs that flank Manhattan Island on the Jersey shore, the condition of water supplies are little, if any better than at Philadelphia and Camden. Out of one source of supply, you may have read in the local press, a Committee of Council fished out, within less than two years, a considerable number of cats, calves, hogs, much other carrion and filth, and one boy. So say the papers. This I did not witness personally. Although, after seeing what I have in surface water supplies, the report does not seem to me at all strange or exaggerated.

In New York State there are several curiosities of this kind. In Ohio also, and in Indiana. But we are in this grand Commonwealth, and should show it courtesy, even if at the cost of neglect to others.

It would amply repay this Congress to go and look at the stream that tumbles over the dam at Joliet. It is a sight for a water supply man to remember his life long. It looks much like a torrent of oil and ink, and in odor forcibly reminds me of this memorable couplet on Europe's famed city of scents, — which ladies call Cologne. Standing on the bridge that spans Father Rhine near the centre of the Cathedral city, Coleridge, cousin John's most practical poet after Shakespeare, taking in the horrible situation through sight and smell, as no one endowed with these useful senses can help doing, calmly drawled out—

> "The River Rhine doth, indeed, wash the city of Cologne :
> But who, in turn, shall wash the River Rhine ?"

Beyond Joliet, in a railway centre of note, a franchise company constructed water works for the city. A large gang of driven wells was used as a source of supply. But they clogged up before the pumpage test was made by the city. The contractor, who seemed not to be harrassed by scruples concerning either veracity or the health of the people, clandestinely laid a suction pipe to a hole in a swamp near by, and was ready to supply perfectly pure tube-well water. The Council and the people reasoned that tube-well water in such a place must be pure and good, and they were easily deceived. It is needless to state that this contractor "unloaded." In the course of summer the supply of "pure water" grew intolerable. It is of record that its odor became so offensive that even the workmen in the railroad shops could not wash in it without stopping their noses with patent clothes-pins. Yet, the bondholders and the city have been meeting occasionally in the successive Courts for the last two years, whilst the water works are rusting in utter idleness, and a thriving city is not alone greatly inconvenienced, but is constantly exposed to destruction by fire.

Dare we look nearer for chances of improvement in methods related to our great calling? We should. It behooves us to be just.

Permit me to be more true to humanity and the object of this Association than to immediate exigencies of ordinary etiquette.

Still raw with recent bereavement, my heart would ache if I dared not remind the beloved countrymen who constitute this mighty city of the danger that threatens them. But few moons since, here fell a friend who was most dear to me. Cherished as a younger brother in my family; adored by a trusting wife and four devoted daughters; esteemed by his business associates as most manly—a success and a force in finances, creating work for thousands of his fellowmen—he was as near a sample citizen as any who to-day treads the soil of this towering republic. But, we took him hence with his strongest daughter, to bury him at his old home. Some of you, doubtless, already have inferred that I allude to the late lordly, manly, energetic, elegant, generous, brave, God-fearing, just and kindly George L. Phillips, President of your Central Union Telephone Company, who, with his darling child, was here stricken to death by typhoid fever. Yes; typhoid fever, of which the celebrated Dr. Edson, Health Officer of New York City, says,—"Nothing is more discreditable to the civilization of the nineteenth century." He also says, and ably maintains, that "typhoid is due to a germ, the bacillus typhosus;" and that "this germ is contained in the sputa and stools of typhoid fever patients."

Yet, right here we behold what we are compelled to witness in so many cities watered from surface supplies. Here is Chicago, a city whose name is as widely known as the United States. Chicago, the most thrifty, energetic and enterprising city on the globe. Chicago, the very synonym of American push and pluck. Chicago, a city of but forty years, already eclipsing most of the oldest cities of the Union in religious, educational, scientific and architectural achievements; Chicago, the young giantess who so recently downed the powerful Dutch Dame of the coast in the halls of Congress, and is now preparing soon to pose as the proud hostess of the entire world of activity and intellect in every realm of progress—is, this day, literally enacting the pathetic part of the famed bird of fable, namely, feeding her trusting brood out of her own bowels.

What comes of this great city's sewerage? It mainly returns to the water supply. It empties into the lake. Everyone knows it. Nor can it be concealed. You throw from yon shore chips or blocks under a given wind, and in three or four days you will find them about the mouth of the supply tunnel, two or three miles distant. Chips and blocks are not sailing vessels. It is well-known that they can go only with the water that bears them. This of itself seems sufficient proof of where the city's sewage goes, and what comes of much of it. The current from the shore to the crib, which the pumping of a hundred millions per day inevitably generates, affords another seemingly conclusive proof. Hence, this sentiment, uttered by a London Divine on beginning of a funeral oration,—"Brethren, in the midst of life we are in death." To illustrate. Please mark this statement of Dr. Edson's: "After investigation of many patients, I have come to the conclusion that typhoid fever is rarely due to any other cause than polluted water, milk, ice or meat. The first named is, of course, the most common . . . . . The typhoid germ is not destroyed by extreme cold. The germs that caused the Plymouth epidemic were exposed to a temperature of 22 degrees below the Fahrenheit zero on the banks of the stream subsequently infected by them after a thaw occurred." So speaks this high

authority, backed by Pasteur, Kohler, Vidal, Chamberland, and a host of other competent experts.

Can you, then, tell me what more is needed than an initial case of this or any other epidemic diseases to convert this or any of a hundred other cities, similarly watered, into a general hospital or charnel-house?

To the dangers arising from the impurity of water supplies is to be added another and very grave one. I allude to the appallingly limited number of sewerage systems as compared with the number of water works plants within our territory.

For the following data, taken from information collected by the *Engineering News* for its forthcoming *Manual of American Water Works*, I am indebted to Mr. M. N. Baker, associate editor of said journal, and editor of that valuable Manual.

In communication dated May 10, 1890, Mr. Baker says:

The total number of water works on our list at the time the following figures were collected was 1,600. Inquiries were sent to each of these works and replies from about 1,400 were returned. Of this number a few failed to state whether or not they had a sewerage system, but as these works were generally in small towns, the probabilities are that they had none. Some towns reported a partial system, and are given in a separate list. These partial systems vary in importance from a few feet of pipe leading from a single house, to a line of pipe the length of the street, or, possibly to several short lines. Doubtless, many towns reporting systems, should have qualified them as "partial," for an engineer who has built several systems and collected considerable data on the subject, recently told me that he doubted if there were 240 systems worthy the name in the United States.

The geographical distribution of the systems and partial systems, reported is as follows:

GROUPS.	SYSTEMS.	PARTIAL SYSTEMS.	TOTAL
New England States	67	21	88
Middle States	110	26	136
South Atlantic States	14	5	19
South Central States	17	4	21
Northern States	99	25	124
Northwestern States	51	10	61
Southwestern States	23	8	31
Pacific States	30	6	36
Total for U. S.	411	105	516

There were also reported as under construction 31 systems. If, then, we add together the systems, partial systems and those under construction, we have a total of 547. Then, allowing that there are 53 systems in the towns which did not report, we have but 600 towns and cities with any kind of sewerage system out of 1,600 towns with water works.

It should be stated that there are now over 1,800 water works in the United States, and of the 200 built since the above named inquiries were sent out, it is known that none could have had sewerage prior to construction of water works, and that not more than a half dozen have taken steps to put in sewers.

Such figures and facts need no comments. Nor does it need to be said that they are a most urgent warning to the people; yes, a warning pointed with disease and death, and one which it behooves the nation to heed if states and municipalities will not.

In thus abruptly dismissing so important a subject, it is assumed that, at least, the oldest of you have watched, and are familiar with the results of imperfect sewerage systems, and of no sewerage at all, in towns and cities having water works, during the last thirty years, and that, consequently, it is not necessary here to rehearse the horrors through which so many cities in all parts of our republic, and the Canadian Dominion and Mexico have passed in that space of time.

Before hastening on, however, it might be best to suggest that too many municipalities, and even individual homes, trust to what they are pleased to call "salubrious climate;" "the best of natural drainage;" or, mayhap, "impervious clay-beds" for protection. All are but as songs of sirens. They can but delude to destruction. If a town like Troy, Alabama, situate on a high, narrow ridge (so narrow that it can have but one approximately level street, and that lengthwise of the town), in one of the most healthful sections of the South, with wells from eighty to ninety feet deep, bricked in cement, and substantially roofed—if a small town so located, and having no water tank save a 20-barrel tank which is used for fire purposes only—can be overtaken with typhoid fever to such an extent as to be compelled to remove every vault from, and stop all waste of water in, its business parts—there would seem to be but very thin chances of escape for towns on level prairie, flat bottoms, in hollows, and on marshy lands that are not thoroughly and well sewered, and yet have comparatively large water works in constant and liberal use.

Pure water and perfect sewerage are the two essentials of civilization, whose chief task is strict economy of useful human life in the fullest possible strength and effectiveness. These two essentials form, in turn, the prime essentials of human progress.

But pure water is no longer directly attainable from natural streams in populated sections of the country. With the rapid increase of our population, manufacturing, and the farming industry, the most of our rivers are becoming little else than mere sewers. It is seriously doubted whether any but a few mountain streams afford other than water largely polluted with dangerous disease germs. Ninety-five per cent. of the streams examined in various parts of the country contain organic animal and vegetable matter in quantities dangerous to health.

In its report to the session of 1887, the committee of the American Public Health Association on Pollution of Water Supplies (of which no less an authority than Prof. Charles Smart is Chairman), summarized most valuable information as follows: "Bringing these considerations to bear on the sewage pollution of rivers and other large bodies of fresh water, your committee is inclined to the belief that the failure of the chemical process to detect minute traces of the contaminating matter is of no practical importance For protection and prevention purposes the knowledge that sewage entered the water seems all that is required.

"The sewage, if not infected one time, may become infected at another, and is therefore an ever-present impending danger to the health and lives of the consumers. But when the constant and extensive prevalence of typhoid fever is taken into consideration, with the vast number of contributors to the sewage outflow of a large city, the sewers of that

city cannot be safely assumed to be uninfected. Nor can reliance be placed on the dilution which takes place in a large stream. Recent experiments on the causative essential of typhoid fever, point to matter in particulate form as the element of danger. Dilution does not dissolve and dissipate into inocuity, as the typhus miasm is dissipated by ventilation. *It is there*, and although one tumblerful may not contain it, another may."*

No less significant is this sturdy statement made by the late learned President of this Association at the Cleveland session: "It is," he says "the vegetable organic, and especially the sewage organic matters in dissolution that we have most to fear, and these multiply as the population increases. It is in the midst of these that the disease inducing germs chiefly generate."†

"But", it may be retorted by disbelievers in the "germ theory," what of such proofs and calculations, if diseases are not propagated by germs?"

I can only reply to what has already been stated, and also say that scientists adhering to the germ theory seem to have nature on their side, whilst it is well nigh positively and conclusively demonstrated that their opponents have not.

(1). Pasteur's treatment of hydrophobia on the basis of the germ theory is as positive proof of the correctness of that theory as is the analysis of ordinary heaven, which, in turn, is as clearly explicit as are the light of noon and the darkness of night.

(2). A strong majority of the Paris Medical Academy recognize no longer any *theory* of disease germs—but a *fact*.

(3). Dr. Salmon's work with the "hog cholera" investigation at Washington shows the germs as plainly in diseased intestines as Prof. Dana showed trilobites in blue limestone.

(4). In the Pasteur-Chamberland laboratory you can see the bacilli or germs with your own eyes under the microscopes.

(5). You can do the same at the Leipsic laboratory.

(6). The same at Berlin.

(7). There scarcely remains a government worthy the name that does not recognize practically the germ theory as a reality.

(8). Very few, if any properly educated physicians fail to do likewise.

And why should they? Let us interrogate the first and foremost teacher for a moment.

It certainly appears that a man does not and cannot, actually, create, but simply invent, come upon, or *discover*. In reality, we only discover means to ends. And means to ends apparently preconceived and predestined, or provided for by seemingly eternal and invisible omnipotence. For instance, it is inferred that Columbus discovered America. It must have already existed. It did. Mr. Thomas Edison has discovered how to catch and fix sounds in a repeatable condition. He calls his machine or invention a phonograph. Great, laudable and useful as is this mighty grasp of a most piercing mind, what is the phonograph but an echo machine? But echo is no creation. There is only a means to wake it at will.

*Vid.—Papers and Reports, Vol. XIII, p. 257, Concord, N. H. 1887.

†Vid.—Eighth Annual Report, p. 14.

Watt and Stevenson discovered the steam engine, we are told. And a thousand others have improved it. But there remains for inventors in this field a future greater than the past. Man and the horses are far more complete engines than any ever yet fashioned by man. These living frames are full of hinted but still undiscovered facts, preconceived and predestined means to ends—waiting the command of such as commune closely with nature.

Ship-builders might, if they would, find the best plans and models in the various kinds of fish for freight and fast fleets. But the first builder seems to have patterned his craft after a swan or a goose, and his numerous followers have only too closely imitated him. Nature emphatically suggests the pickerel as a model for the swift cleaving of waters. She has amply provided the best practical teachers in that art; and likewise in all others that we know of. Any way we turn, in whatever sphere of knowledge and work we enter, we may and can find ample provision already made for all incident wants. As the mature parent for the child, or the teacher for the pupil, even so a seemingly all-wise and Omnipotent force seems to have gone before man in all terrestrial creation, at least, and prepared and provided for all the wants anticipated by human existence. Man seems to have only to take and use according to laws which impel incessantly to increasing development, in his strongest effort toward which he finds his greatest happiness.

Now, if it be true that all visible things and known wants are anticipated and provided for (and certain it is that all recorded history seems to affirm it), it may become easy to vastly improve health, longevity and the power and expanse of life itself. One step further.

It appears positive enough in all known creation that like produces like. The whole world of science and practice fully agrees with Him who asserted that "Whatsoever a man soweth, that shall he also reap." Not something else. But *that* which he sows. And no sage or god of any generation or age seems ever to have questioned that this utterance of Jesus, the son of Mary, was as true to the truth as the needle to the pole.

It, therefore, appears safe to assume that man does not and cannot create, but, on the contrary, that all things are preconceived, and in a sense, predestined—or under waiting orders, so to speak—to spring into active use at the bid of man. It appears undenied and undeniable that such is the case in the vegetable and animal kingdoms. It appears equally undeniable that the same is true as regards the elements and agents in what is now assumed to be inanimate existence.

When, then, all visible life and things recognizable with the unaided eye are known to be governed by the same general and firmly established laws, what possible reason can common sense produce to show cause why the microscopic world should be governed by a separate and totally different set of laws and methods? None but lack of necessary information. What *could* there be? Could it be that this nature who fixed the kinds and purposes of life in herb and bird and rock; in creeping things and the mammilaries of land and sea—who immutably set limits to the globe at our feet and filled immensity with worlds and systems of worlds in orbits and spaces from which they have stirred not an iota in thousands, and, mayhap, millions of years, could proclaim one thing in leaping human blood and bone and sinew and soul, and then contradict it in microscopic existence? Why infer such a trick? Nowhere on the

globe has that nature been observed to set hill and hollow on one and the same spot. Nowhere barrenness and fruitfulness in one and the same place. Nowhere darkness and sunshine at one and the same time in a given space.

Besides, the microscope, as far as improved (as before incidentally shown), positively proves that, as far as the aided eye has seen, there is no difference whatever, and that the world is a unit.

This being true, it follows that —

First.—You may and can breed disease if you will, or not if you won't.

Second.—That as you sow, you must reap, in your water supply as in your garden. And,

Third.—That the weeds of disease *will* spring up and bear their deadly fruit except you carefully watch and check and eradicate them. Your field is subject to precisely the same laws as that of the farmer on your water shed. You know the rest.

Let me suggest that my humble experience convinces me that death, in the sense of absolute silence, or sleep, is a mere fancy. In fact, there is no silence in what is called death, nor can be.

You see, life is only dependent existence engrossing or accumulating by feeding, etc.; whilst death, so called, appears to be the same existence or life reversed—and become, in a sense, independent, save from its own body, which it seems now active in fining back to dust, and, possibly, experience bodied into form impalpable to our present senses. Hence, it appears, that healthfulness is life active, whilst unhealthfulness is life—not passive, but at or about the turning stage toward destructure, or gradual fining. That is why it may be safe (until we can do better) to consider and treat disease as colonies of microscopic creatures whose life task is predestined to foster destruction and decay.

As for a more practical definition of life *per et in se*, there is none as yet. "'Tis a pity 'tis true, and true 'tis a pity," but even at this hour of the nineteenth century, our physicians and metaphysicists seem not a whit more qualified to speak than were the Egyptians under King Asah and his administrator, Pta Hotep, who are at times taken to have believed that the diseases of humans were but the spirits of their dead contending with the living for the exclusive companionship of mutual friends or relatives. But be that as it may, we do know that nature is so immutable in her exactments that, at her counter, every rational creature must pay for what he takes and take what he pays for, and also render an account of his every act, whether of omission or of commission—and that in any and every event, your reward will and must be the logical result of your act.

Again, assuming that it is accepted as indubitably established, that every normal creature is endowed with seed of his kind, it must follow that diseases, which seem unquestionably to appear and exist like a fire, producing an effect of an active, waxing and waning life, and being, in fact, an essential means of perpetuating life, as, for instance, in gestation and birth—should be treated as are all other kinds of life whose increase or existence it appears desirable to stop either partially or totally. Here is a proof that it can be so treated effectively.

A remarkable operation took place before the Surgical Congress in Berlin, Prussia. The anterior chest wall and lower wing of the affected lung were removed, and the heart could be seen beating in the chest

cavity. The patient is doing well, and the Congress declares that consumption is now curable.

Is this not precisely like moving the piece of leavened dough from the lump in order to stop the process of leavening? Or plucking the dandelion from the lawn to stop its rapid seeding?

But you, having chief control of the medium of life, can do better than did the operators for the Berlin Congress. You can, to a great extent, avoid the breeding of consumption, and of many another fatal disease, by keeping their germs out of water supplies, or by sterilizing them.

In this connection it would be of great importance to learn what the germs of a given disease are descendants of, or ascendants to. You, of course, understand that, as before intimated, life is much like a pendulum, swinging to and fro from finest bits to largest bulks, and the reverse, incessantly. And disease germs, like their results, are assumed to seed for decay, whilst active life, or health germs, so to speak, seed for growth from stage to stage of a given line of developing existence, such, for example, as man's, which passes through at least three aquatic stages of life to the present, and in the present probably is seeded and developed what is called the spiritual state. So nature indicates. If you would kindly urge this matter on the attention of your respective chemists, to the end that the researches of many may soon result in the light needed, you will confer a genuine benefit upon mankind.

A highly learned and able body, the Paris (France) Academy of Medicine, early this year, substantially proved, through long and vigorous discussion, that if you wish to check the progress of consumption (or what is scientifically known as *phthisis pulmonalis*), which appears obviously contagious, you carefully destroy the patient's sputa, and the rest will take care of itself.

Last month, a peasant from Servian village of Beljavaer drew 700 ducats from a bank in an adjoining town. On his way home in his wagon, he offered lodging to six furloughed soldiers, whom he overtook on the road. He gave them a good supper, and lodged them in his barn.

During the night a gang of burglars with blackened faces entered the house and tortured the peasant by singeing his feet and hands to force him to give up his money. His wife ran to the barn and aroused the soldiers, who captured and bound the robbers to a tree. At daybreak they washed the robbers' faces and discovered in them the County Clerk and his Constables.

In too many cases of deadly epidemics, if you were to wash away the popular darkness of ignorance back of which are safely hidden the parties responsible for all the horrors of wide-spread diseases and scores of untimely deaths, you would likely behold the city's Mayor and Water Committee, or, may be, the Chief Engineer and Superintendent, with the latter a plausible franchise company too greedy of gain to have any restraining regard for human health or life.

As a final suggestion, let me say that if anything is more clearly indicated than all others in nature, it is that water is to the globe what blood is to our bodies; and that as blood is purified and utilized, so water is to be. Evidently, nature's intent is that surface streams shall be sewers, or as conveyors of the crude blood in the living body; and that subterranean streams shall be as the veins that distribute the pure

blood to the capillaries. If it be so, then, water supplies for drinking purposes, at least, are to be looked for in the ground, or seized and closely confined as they issue therefrom, and before they become contaminated or impregnated by air or earth's surface. Nature speaks this. In the great briny ocean and the effect of sun heat thereon: in the ebb and flow of the seas; in the fields and forests, whose striving billions of fixed lives feed on the *fat* of rains; in the great branching streams that return the earth's waste and decay to the seas, whereby the globe renews its form and power, and the watery kingdom is fed; in crystal springs, leaping geysers, healing artesian waters, and the stubborn fact that they who fail to hear her speech, and obey her voice, never escape with impunity.

Mr. Tubbs: I am greatly gratified by this paper while I am not particularly alarmed at the difficulty, and while there are certain duties dependent upon us as practical water works' men, yet I thank the gentleman for the paper. It is a very valuable contribution to the literature of this Association, and while I would like to say a few things yet I would like to hear from Prof. Leeds, and I think the time is so nearly up for adjournment that he will not have a chance to do himself justice, and I therefore move that we adjourn until 8 o'clock this evening and that Mr. Leeds be granted the floor at that time.

The following resolution offered by a member was read by the Secretary:

Whereas, The investigation of the relations which exist between the growth of vegetable and animal organisms and the offensive taste and odors which frequently exist in the water-supplies, is a subject at present very imperfectly understood, but at the same time of great practical importance to water engineers and the public generally, Therefore:—

Resolved, That it is the sense of this convention that the investigation of this topic is one which lies within the particular scope and objects of the American Water Works Association, and, that a committee, having this object in view, should be appointed and requested to report at our next Annual Meeting.

Motion adopted.

The President appointed as such Committee, Prof. A. R. Leeds, L. J. Le Conte and L. H. Gardner.

Meeting adjourned at regular time.

EVENING SESSION, May 21, 1890.

Meeting called to order by the President at eight o'clock.

The following applications for membership were read.

Samuel G. Artingstal, Civil Engineer, ... Chicago, Ill.
John H. Turner, Civil Engineer, ... Mobile, Ala.
R. L. Saunders, Civil Engineer, ... Jackson, Miss.
J. F. Gleason, Sup't Water Works, ... Joliet, Ill.
M. W. Corbet, Sup't Water Works, ... Aurora, Ill.
The Edw. P. Allis Co., ... Milwaukee, Wis.

Motion that the rules be suspended and that the Secretary cast the vote of the Convention for the above applicants for membership. Carried.

THE PRESIDENT: Professor Leeds has the floor for discussion of Mr. Monjeau's paper.

PROFESSOR LEEDS: Mr. Chairman and gentlemen. It is with sincere regret that very unexpectedly the duty of opening the discussion upon the paper of Mr. Monjeau has devolved upon me. Last evening I had the very congenial task of bringing more prominently to your notice, as I thought, the very great merit the paper by Mr. Le Conte deserved, the remarkable series of observations made by him, a very valuable contribution to hydraulic science that he made in his paper; but unfortunately in connection with the paper of Mr. Monjeau which brought a very large accumulation of material to our attention there were many statements made that I do not think can be verified by accurate observation, and so many statements with regard to the present condition of the various water supplies in the country which I think were somewhat over-colored, and finally certain conclusions with regard to the best water supplies which I scarcely think would be endorsed by the experience of the members generally that I cannot take with regard to that paper the same attitude of general commmendation.

Now with regard to the various water supplies which I think were characterized in terms of a stronger nature than we should deem judicious, I will mention in connection with them one statement in reference to the water supply of Philadelphia. Bad as that is I think it

is more what might have emanated from a cursory observation than anything borne out by the facts of analysis, than that which comes from the contamination of the water supplies from the large cemetery located above the pumping works. I do not think any contamination whatever comes from the bleaching out of the bodies of the various citizens of that town.

And with reference to certain other water supplies; it was certainly a great matter of surprise to me to hear the water supplies mentioned in quite such strong terms as I heard this afternoon; but I do not propose to dwell upon these matters. I think there are others who will take up their consideration. But there was one statement made in the paper which gave me a great deal of pain on the ground of nationality as an American. I understood Mr. Monjeau to say, "To take our scientists as a class they are governed in the pursuit of knowledge by the consideration of gain and money rather than the advancement of knowledge." Still more I understood Mr. Monjeau to say that the professors in our colleges instead of devoting their energies to the accumulation of new material in science; spent their best energies in the acquisition of gain.

Now, Mr. Chairman, if I have taxed Mr. Monjeau unjustly I would like very much to hear again that paragraph. If I have taxed him unjustly I am very desirous of stopping right here and saying nothing further in that connection; but if Mr. Monjeau will be kind enough to refer to his notes and finds there that Americans, that the professors in American colleges can be justly stigmatized with this accusation, which is perhaps of the gravest character in a public assembly, I do not feel that it would be just to the class of men spoken of to allow such a broad statement to be spread upon our records without some word of protest. Mr. President I will ask Mr. Monjeau if he will kindly favor us again with that particular paragraph in his remarks.

Mr. Monjeau: I regret that I do not know where that paper is or I should be very happy to accommodate the gentleman on the floor, but I have not the paper. However, if this will do I will state that the interpretation put upon the paragraph which I think I can understand is alluded to, is the farthest from my intention to

convey anything of the kind, having been myself right in the ranks of teachers, and feeling to-day heart to heart with them and devoting what remains of health and strength in me in trying to do all I can in that line; in fact, in this very city I have tried and worked to found a university of the United States, and I have not as yet given up the idea of starting something that will be as good as we have in the land. Pardon me, my dear sir, I did not mean to convey any such meaning. My heart is with the American professor, but I was trying to exhort (I believe that is the term) my brethren to rely upon themselves and not wait until scientists outside of this institution should come to our help. That was the intent.

Professor Leeds: Then, Mr. President, I will understand that I derived an idea that Mr. Monjeau scarcely intended to convey.

It appears to me that any paper read before a general audience of this kind which either by intimation or by direct inference would seem to detract from the labors of American professors in every branch of knowledge we certainly as Americans and as men of science cannot for a minute listen to.

Mr. Monjeau: I can assure you there is nothing I would welcome more than discussion, and I will now, if you will allow me, beg your pardon and the pardon of this Association for having been backward in not being forward in carrying out the idea that was suggested last year, that we should have the papers which are to be read published on slips so that we could all have copies and then be better prepared to criticise. However, to the learned gentleman who has been so eloquently and so forcibly defending American scientists I desire to say that I either misexpressed myself or he misunderstood me, I meant to refer to men of science in the line of the paper which was written.

The Secretary here read communications addressed to the Association from the following:

Dexter Bracker, President New England Water Works Association, and F. W. Gerecke.

One of which from Mr. Gerecke, contained a paper to be read before the Association, which upon motion of

Mr. Gardner was referred to the executive committe for consideration.

The Association next listened to a volunteer paper by Mr. John A. Caldwell as follows :

PUBLIC FILTRATION—THE OLD AND THE NEW.

BY JOHN A. CALDWELL, BAY RIDGE, N. Y.

Until quite recently almost the only system of water filtration on a large scale was in open reservoirs having practically porous bottoms. The bottoms were composed of sand, gravel and stones, the water to be filtered flowed over the sand, passed through and out at the bottom, or entered at the bottom, passing upwards and out at the top. The coarser impurities lodged in the sand and were washed out by a reverse current, or, in the case of downward filtration, were removed by paring off thin slices from the top portion of the sand at stated intervals, and at longer intervals removing the sand altogether and washing it by hand.

Where local conditions were favorable, deep cavities or trenches were dug alongside of the river or lake, the water percolating through the bar thus formed became a source of supply.

Some times a couple of open walls were built across a corner, or through the center of an impounding reservoir, some few feet apart, the space between filled with gravel or sand and the suction of the pump connected to one side only.

In all cases a mere straining of the water was aimed at. Of the first, England and the Continent present many perfect examples. Of the second, Los Angeles, Cal. ; Hamilton and Toronto, Ont. ; Nashville, Tenn. ; Lowell and Attleboro, Mass. ; Newark, N. J., and Providence, R. I., are examples. Of the third, Waterloo, N. Y. ; Litchfield, Ill., and, I believe, Springfield, Mass., have tried such plans.

Of the above list, Los Angeles alone lays claims to success. The conditions at that point being peculiar.

Of the first there are a few examples on this side. Poughkeepsie, N. Y., being the pioneer and best known. I find Stratford, Ont., has something of the kind, also St. Catherine, Ont., and I believe Pawtucket, R. I. Until recently, New Brighton, Pa., had a device of the kind.

Each of these systems has its advocates. Opinions on the subject are as varied as men's minds. Filtration in this country may be said to be in its infancy. It is on trial. No city adopts it without inquiry. This will doubtless be the case for some years to come. Although the responsibilities of making a choice have driven water boards and engineers to fall back on ancient precedents, this action has not been the means of saving them from failure at many places. One of the most conspicuous causes of failure has been the neglect to provide adequate means for washing the filter beds—in the case of beds—and keeping the bars free and open in cases where deep trenches were dug alongside of the river or lake of supply. Many failures are reported from this cause, the most recent coming to our knowledge in the annual report of a large city, in which it is stated that the water within the trench, which at the beginning of operations was level with that in the river, was at the end of one month one foot lower; at the end of two months five feet lower; and at

the fifth month no water passed through the bar, though the river remained the original height.

THE MODERN SYSTEM.

Some few years ago a system containing many novel features came into public use in this country. Its successful adaptation and introduction has fairly won for it the title of "The Modern System."

To enumerate some of the radical changes this system involved, I mention:

First—The use of enclosed tanks, made of boiler plate as against brick and stone receptacles.

Second—Filtration under pressure, as against open gravity filtration.

Third—Rapid filtration, through small areas of bed, as against slow filtration through large areas of bed, the difference being in some cases as high as forty to one.

Fourth—Daily washing of the bed within the tanks by means of the water pressure, as against periodical hand scraping of the surface and removal of the beds by hand labor.

Finally—The use of a coagulant to curdle the impurities before filtration, after the fashion of nature.

The aggregate results of these changes may be briefly summed up as a greatly improved filtrate at much reduced cost.

The disadvantages and positive objections in the old system sought to be overcome in the new, may be enumerated as follows:

First—The original cost of the large bodies of land necessary, on which to place the filter plant, the same being in many cases near the city to be supplied and the land proportionately high in value.

Second—The cost of such large excavations, of the building material, labor, and the large amount of material for filtering.

Third—The comparatively large operating expenses, gangs of men being in constant attendance, scraping the fouled surfaces and removing some portions of the bed unceasingly.

Finally—The objectionable quality of the resultant water, from a sanitary point of view.

The best examples of the so-called filter beds are to be found in England. While the best examples of the so-called Modern System of water purification are found in America. To compare data from these two systems, one against the other, is treating the subject with exact fairness.

It is the weighing of both in the balance, to see which is found wanting.

COMPARISON.

The first cost of the English filter beds was $30,000 per million gallons of water filtered daily. A recent published statement placed the first cost of the beds at Carlisle, England, at a higher figure, also those for the city of Liverpool. While the average first cost of the Modern System is not more than $12,000 per million gallons of water filtered daily.

The operating expenses at Leeds amount to $5.00 per million gallons, while that of a Modern System is stated in the annual report, just published, to be $2,093.39, or $2.76 per million gallons filtered. Of

this sum, $730 was for labor and $1,363.00 for coagulant, or 97 cents per million for labor and for coagulant $1.80 per million. The item of $730 means the labor of one man 365 days at $1.50 per day and a boy at 50 cents a day for the same time.

These figures show the first cost of the Modern System to be four-tenths the cost of the old filter beds and the operating expenses to be a little over one half. If a plant equal to the English filter beds was to be built in this country the differences in the prices of labor and material would probably run the first cost up to $50,000 per million gallons filtered daily, and the operating expenses to $8.00 per million, making the first cost of the Modern System only one-quarter that of the old, and the operating expenses only about one-third.

It should be remembered that in the Modern System facilities are provided for partial subsidence before filtration, thus reducing the alum account.

The average throughout the year just passed was $\frac{6}{10}$ of a grain to the gallon of water filtered. There were times throughout the year when the quantity used was only one grain to 3¼ gallons of water filtered. At other times none at all, and at no time was the amount over 92 grains per hundred gallons.

More recent practice has reduced the alum account one-fourth, by using sulphate of alumina in the place of alum.

The sulphate of alumina contains 48 to 56 (say 50 %) per cent of sulphate of alumina, which is the active agent, while commercial alum contains only 38 per cent. The price of each is about the same, so there is a net saving of 25 per cent. Had sulphate of alumina been used during the year in the Modern System the cost for coagulant would have been reduced from $1.80 per million gallons to $1.35 per million, or $1,022.00 for the year.

It may be stated that the man in charge of the filter plant had other duties, and did not give his whole time to the filters, but allowing that he did and that he was paid the wages he would get in England for the same work, we find the operating expense of the Modern System to be only: coagulant, $1,022.00; labor, $365.00; making a yearly total of $1,387.00, or $1.83 per million gallons filtered, or about one-third the cost of operating the old system, if the plants were built side by side in this country by the same labor and costs of material.

So far I have said nothing about the *quality* of the resultant water.

In the old systems no attempt is made to do more than simply strain the water of the comparatively coarse impurities, while in the new system actual purification takes place. The water, in some instances, proving upon examination to be absolutely sterile. It will be admitted by the warmest advocates of the new system that slow filtration is more efficient than fast when no coagulant is used in either case, but it must be admitted, on the other hand, that by the addition of the coagulant, water may be filtered forty times faster than by the old system and be rendered very much purer.

Let any one who doubts this pass water through a modern filter forty times slower than the rated capacity of the filter and he will find that with a sand bed averaging double the depth of the old filter beds, the results will not compare with fast filtration and a coagulant.

What is the action of the coagulant? The sulphate of alumina of commerce contains 50 per cent. of Sulphate Alumina and percentage of water.

The Sulphate of Alumina becomes a hydrate of Alumina, a white gelatinous mass, which diffuses throughout the water, much as a drop of red ink would tint a tumbler of clear water. Each individual particle of this gelatinous mass becomes coated over with the matter within its reach, as ones clothes would become coated over with tufts of cotton in a cotton factory, the action being purely mechanical.

Matter that previous to coagulation was so fine as to go through the filter bed with ease becomes by force of circumstances part of a community of particles, the smallest of which communities is larger than the largest mesh of interstice of the filter bed, hence everything in suspension, after coagulation is caught, and held in the filter bed to be discharged with the daily washing. The importance of this adjunct to a filtering system will be apparent when we remember that some species of bacteria are no larger than 1-25,000 of an inch, and are capable of passing through porcelain tubes. The food that these bacteria exist upon must be smaller still, so it will be seen how hopeless must be the attempt to get pure water on a large scale without coagulation, in the present state of the art.

The old filter bed system invites another trouble which has not been touched upon, viz: the necessity of exposing the water to the sun. Short lived germs are rapidly developed—their death means putrefaction, also prolific growths of algæ are promoted on the sides of the enclosures and the surface of the sand.

In warm climates like ours, these conditions are aggravated. Various gases of decomposition permeate water and give rise to obnoxious odors, and other impurities not eliminated by merely straining through the sand. To roof in the large bodies of water is very expensive.

In the modern system the filter beds are not only covered over but the filtering is done under pressure. The water is not exposed during any portion of the process and passes to the mains the moment it is filtered.

Finally, the water is rendered so completely free from impurities by means of the coagulation that it may be kept for months without apparent deterioration.

A paper on the classification of water rates by Mr. Priddy was read, who prefaced his remarks as follows: "When I started to prepare this paper I supposed I was called upon to prepare a paper on this subject and I sent out a number of requests for the different water rates in different localities. After that I saw another member had prepared a paper on this same subject and that is why I did not prepare a more elaborate paper or bring a plat showing the scale of the different water rates that are now in use throughout the United States. After receiving something like one thousand replies to the circular I sent out I found there were no two alike, and

invariably a very vast difference existed between the modes of charging for water throughout the United States.

C. N. Priddy then read the following volunteer paper on the Classification of Water Rates :

ON CLASSIFICATION OF WATER RATES.

On January 3d I sent out a circular to 1,500 cities in the United States asking for their water rates, etc., to which I received about 1,000 replies, and was very much surprised at the wide difference and manner in charging for water. Hardly any two are anywhere near alike, and after examining them I have come to the following conclusion: To begin with, in my opinion the only just and equitable way to sell water is by meter measurement, but for various reasons in a great many places it is not practicable. As circumstances are so different in all places, I will only try to treat of those rates that are of the most importance and in which there is the widest difference.

First, the family and dwelling house rate, which is the most important of all. I think it should be charged by the occupancy or the number of persons using water. Also closets and bath tubs should be proportioned the same. I do not think there should be any extra charge for hot water or the fixtures for same, or any extra charge for sinks, washstands or faucets as all these are conveniences and are not supposed to take any more water, as all persons are supposed to use all the water they want regardless of the convenience. As for urinals, self closing, I think the rate should be about one-half that of the closet. For urinals constantly running, which I consider one of the greatest water wasters we have to contend with, the rate should be from two to eight times as much as closets, according to closet usage. And I think a wide distinction should be made between good and poor fixtures of all kinds, especially in water closets, as some poor ones will waste more in a day than a good one will use in a month. Therefore, it will be an inducement for parties to put in good plumbing and fixtures, which will be quite a saving to the water companies in the way of waste water.

At this juncture Mr. Bull produced a piece of water pipe which he had "stolen" from the ruins of Pompeii upon a visit there some ten years ago, and which he earnestly assured the Association was eighteen centuries old. This relic of by-gone ages was eagerly examined and commented upon by the members present.

The Secretary next read the following question from the Question Box, which was not commented upon.

QUESTIONS.

In case a Water Works Company or municipality owning water works should desire to procure and set a large number of water meters, and had not time or facilities for instituting an exhaustive test of the

merits of the several kinds of meters on the market, in case of inviting proffers for furnishing said meters, what guarantee should be required of the manufacturer in said advertisement?

Another question was read by the Secretary as follows: "How can we best educate the people not to waste water?"

MR. CAMERON: I asked that question, and I would like to hear from a great many of the intelligent men here present on that subject. I have got an idea how we can educate the people. A few years ago while in the city of Chicago on a cold winter's night I heard a gentleman say to his servant, "Gallagher, it is going to freeze to-night; go and turn on that water and let the pipes keep from bursting." Instead of saying to Mr. Gallagher, "Go and shut off the water and drain the pipes," he said, "Let-er go Gallagher." (Laughter.) Now, this gentleman was a member of the church, a man who stood high in society, president of a bank and who would no more think of going into your safe and taking out five or six dollars and throwing it into the sewer than he would of flying, and yet that is just what he was doing, and simply because he was ignorant of the fact. Now, the remedy is educate that man by turning off his water. You turn off that man's water and you see that he pays a dollar and that is the way to educate him. If one house to house inspector won't do it put on one hundred, and every time that man hears any water running he will make things so warm around the house that the people will think that they have a continual nightmare. They must be taught to use the water legitimately and if they do not do so see that every mother's son of them pays a dollar, and every time he hears that water running you may be sure he will not say, "Let-er go Gallagher."

MR. LINNEEN: Chicago is a little differently situated than Memphis. Chicago has the great lake Michigan at its door, and a great amount of water to spare; otherwise these arbitrary rules might apply. Now sir, I am opposed to such arbitrary rules. There are instances, particularly in the north where it becomes necessary to let the water run at night, after the fires go down, in order to save your plumbing. I favor making the rates high enough to provide for the waste, and then let them

use the water. I don't believe in arbitrary rules for controlling the use of water.

A Voice: How would that work in a city of ten thousand consumers on a cold night and all availing themselves of the privilege?

Mr. Owen: I am a little surprised to hear advocated the practice that Mr. Linneen has suggested. It seems to me and must to all thinking people that we should deprecate the wasting of water not only in cities where the water may be as free as in Chicago, but in every other place where every gallon of water costs money, and I think that this Association should deprecate anything of that sort.

Mr. Cameron: I think Mr. Linneen never intended to advocate anything of that sort in truth, or if he does, then he don't belong to this Association.

Mr. Priddy: I agree with Mr. Cameron. The only way to educate the people is to put on a fine. I have had a great deal of experience in this direction. We have very cold weather for six months in the year. We make a house to house inspection every night during the winter; we make them generally from twelve o'clock to four in the morning when they are not looking for us, and we can detect whether they are letting their faucets leak. If you allow them to let their faucets run and simply give them a nice talk it wont be a week before you catch them at it again. The only way is to fine them. When it comes out of a man's pocket then he finds out what he is paying for. If you do as Mr. Linneen says, let them all run, where is the water works that can stand it? Our experience has been, and we have had a great deal, that where you fine one man in a block all his neighbors know of it, and it soon goes from one to the other, that Mr. So-and-so was shut off for letting his water run, and the consequence is that we save a great deal of water and a great deal of pumping.

Mr. Watts: I would like to ask Mr. Cameron suppose the courts would not uphold you? We have had a little experience in that direction.

Mr. Cameron: It is part of the rules of our company and the rules are a part of our charter and the city government will support us.

Mr. Watts: We have the same rules, but we shut a man off and charged him a dollar and he got judgment against us for fifteen dollars. I think the proper way would be to put a meter on the consumer.

Mr. Linneen: I think my brother members are laboring under a misapprehension as to the meaning of what I said. I said I was in favor of every consumer paying all that it was worth, but I was opposed to arbitrary rules; rules that bring about dissatisfaction between the consumer and producer.

Mr. Priddy: Did you ever make a charge for actual waste.

Mr. Linneen: No sir. The only way you can stop it is by meters, and the only way to guard against it is by charging for it what you think is right for this waste.

Mr. Owen: In the city of Hoboken we formerly received our water supply from the same source as Jersey City, but by a subsequent arrangement the contract was transferred to the Hackensack Water Company. When the old supply was turned off and the new supply was turned on, we found the supply was inadequate to the population. Instead of using sixty gallons a head a day they were using one hundred and twenty gallons a day. By inspection they have reduced that consumption from one hundred and twenty gallons down to between seventy and eighty. That is not by meters but by hard work.

Mr. Bull: If we are going to let it be known that this is something that water works want to encourage I think we are organized for the wrong purpose. It seems to me that the stopping of this waste as far as possible is the corner stone of our Association, and I think we all know we cannot stand anything like that which Mr. Linneen speaks of.

MR. CAMERON: I would like to ask Mr. Linneen how much water would pass through a sixteenth inch pipe under forty pound pressure.

MR. LINNEEN: Quite a lot.

MR. MILNE: I think every intelligent man thoroughly appreciates this subject. Several years ago in convention I read a paper touching on this subject. In my opinion a water meter is not only an instrument to save the waste of water, but it educates the consumer of the water to an appreciable sense of what constitutes good plumbing work in the house. It is a silly excuse in most cities that it is necessary that water should be suffered to run to prevent the pipe from freezing. The difficulty is not so much in the temperature, but rather in the location of the plumbing work in the house. I am one that believes that the owners should see to it that the pipes are placed, as far as possible, to prevent freezing. That is the natural consequence in placing meters in many houses in northern latitudes. The idea of the meter is simply to educate the people to a proper appreciation of the subject. The idea is to save what you have already acquired. Any engineer of sense knows that. Take the city of Chicago, the people of which receive their water by pumping, and although their water supply is unlimited, yet it is perfectly ridiculous that there should be used in this city one hundred and seventy gallons per head per day. I say it is perfectly ridiculous to think there is such a waste. That is the point which Mr. Tubbs claims in his paper. Every engineer will concede that waste of water is the bane of every water works in the country. There is no doubt of it; wilful waste, or criminal waste, and these people are innocent of that waste. There is nothing so cheap as water when you have it; and there is nothing so dear when you don't have it.

MR. ALEXANDER: I would really like to know whether or not it is possible to introduce meters. Now at my works it costs me $80.00 a million gallons to raise the water to our reservoir. Now I hear a great many say there is nothing in meters, and I want to know from

these gatherers of water if they think it is profitable to introduce meters.

Mr. Gardner: I will say our President has a very exhaustive paper on this subject which I now move be made the order of business to-morrow morning. Carried.

Mr. Kelley: I want to say one word in reply to the gentleman on the right (referring to Mr. Owen) with reference to the city of Hoboken. It is this: It seems to me that he left the false impression upon the members of this convention that they did not accomplish anything through the use of meters in Hoboken. I am sure he is very much mistaken. I have it direct from Mr. Brush that he owed the great saving of water to the use of meters. In one portion of the territory you cannot get any water without attaching a meter. They have in use I think somewhere in the neighborhood of four thousand meters, and he has told me frequently that he attributes the saving of water in the city of Hoboken to the general application and use of meters. I do not say that second-hand, I say it direct.

Mr. Owen: I will say that this statement I got from Mr. Brush himself, before meters were placed upon the consumers; but before they were placed a reduction was made. The figures I gave were those right after we had made that contract.

Mr. Tilden: I think Mr. Linneen's position something like this, as I understand it, that a water company or a municipality in making their rates should charge sufficiently to allow the consumer to run, we will say, a sixteenth inch stream if necessary to prevent pipes from freezing. Now a sixteenth inch stream does not look very large when you see it running, but you take a little example, for instance, of allowing one thousand such to run. Suppose that each one had a privilege of running a sixteenth inch stream to prevent the pipes from freezing, I have ascertained by actual experiment that with a fifty pound pressure, one thousand taps running would consume about 12,000,000 gallons in twenty-four hours, which would be a pretty large supply; if they run a quarter inch stream they would consume about 29,000,-

000 gallons in twenty-four hours and a half inch stream about 80,000,000 gallons.

Mr. Benzenburg: A consumer in opening his faucet to allow a sixteenth inch stream to pass away does not run anything like the amount of water he would under a full pressure. I have made a number of experiments myself so that if I passed anywhere along and saw water running I could tell how much it would represent, and I know that a sixteenth of an inch stream amounts to very little in twenty-four hours. If allowed to run by turning a faucet sufficient for a sixteenth inch stream to pass out if you allowed the whole pressure there would be considerable waste of course, but in the other case it would just trickle down.

Mr. Tilden: I think Mr. Benzenburg will allow that the amount of water that would pass through a sixteenth of an inch stream would hardly be sufficient to keep pipes from freezing. I suppose that Mr. Linneen did not mean that the faucet was to be allowed to simply trickle down. Of course a sixteenth of an inch stream in that case would waste very little water; but that there should be enough to keep the pipe from freezing. In twenty-four hours about 1000 gallons of water would pass through a sixteenth of an inch orifice at fifty pounds pressure.

Mr. Lakin: I do not believe in theory. If I want to know how much my people are wasting I take my figures from my pumpage. I do not believe in wasting water, but I am perfectly willing that they should waste enough to keep their pipes from freezing. I make all my experiments right at the pump. On a cold day when I know they are wasting water, I have never found any such quantity of water running to waste as I have heard of here to-day. My pumps have never had to deliver the large amount of water that has been mentioned here.

Mr. Benzenburg: I have made test myself at my own place as I said before in order to be able to determine at once how much it represents in twenty-four hours. I have done so repeatedly day after day, and week after week in order to school the eye to determine at a glance.

A small stream going through a half inch faucet that will run continuously in a sink without a break or without breaking into drops represents ninety gallons per hour. One with a little bit further opening of the faucet will represent one hundred and forty gallons an hour. One that will run through without force or pressure or merely fill the opening of the faucet represents five gallons a minute or three hundred gallons an hour. There is no doubt but what the wastage of water through faucets is an enormous percentage compared with the legitimate use of water during the day hours. I have repeatedly during cold nights and cold days had the amount of water pumped taken every fifteen minutes for twenty-four hours continuously so that I could compute almost acurately the amount of water that was being consumed and wasted during the day hours or during the night hours, and during the severe cold nights I have found that the consumption at night was sometimes in excess of the pumpage or consumption during the day, when the water was being used by all the business houses and manufacturers, showing distinctly that between the hours of half past nine and half past ten there was an increased consumption and then holding an almost uniform rate until four or five o'clock in the morning when there would be a slight increase, and at seven o'clock or half past six to seven o'clock a decrease, the increase about five o'clock would come from those engaged in getting matters ready for business. This certainly shows that the wastage is fully one hundred per cent or one-half of the amount that should be legitimately used. When we began to force meters onto consumers our consumption had reached within five per cent of the capacity of our supply and within three per cent of the pumping capacity of the works. After placing meters on the business houses in general, within three months it reduced the consumption forty per cent, and to-day the consumption is considerably below what the consumption was before we began to force meters on the consumers. Now, if the consumer can be as careful as that when he has a meter placed upon his premises it certainly is not asking him too much to take the same care when there is no meter on his premises.

Adjourned until 10 A. M. Thursday.

THIRD DAY.

THURSDAY MORNING, May 22, 1890.

Convention called to order by the President at 10 A. M. Mr. Holden was called to the chair temporarily, and the President read the following paper:

WHO SHOULD OWN THE METER, THE COMPANY OR DEPARTMENT, OR THE CONSUMER?

At our last annual meeting a paper was presented by Mr. Darling entitled, "Should a city or town furnish meters at its own cost to consumers of water," in which he treated the subject most ably in the affirmative. Since that meeting I have been requested by several members to take the negative of the proposition.

While the gentleman's argument was a strong one in favor of the use of meters, he failed to present any sound facts or figures to substantiate his position that the cost of the meter should be borne by the water supplier. The question is rather a complex one and difficult to handle, being one rather of theory and personal opinion than having reliable data in the form of facts and statistics to sustain an argument upon either side. Realizing this fact I submitted the question in the form chosen for the title of this paper to a number of men prominent in the profession without knowing what their preconceived views were. That the opinions might not be biased and should represent all classes in the business of water supply, twelve municipal works, twelve managers of private corporations and twelve engineers of note and experience not directly connected with management were chosen.

I have taken the liberty of appending their replies, and also the liberty of, to some extent, discussing them, or rather making a friendly criticism of the reasons assigned in the support of their opinions. In so doing it is with the hope that no exception will be taken thereto, nor that it will be considered that any unfair advantage has been taken, as such is certainly not the intention.

John L. Ogden, Chief of Water Bureau, Philadelphia, Penn.:

"Our experience with meters is somewhat limited, as we have but a few hundred in use. The city owns the meters. In some instances where the revenue would probably amount to a small sum a meter is applied on the condition that the applicant pay for the meter, which is to remain the property of the city.

Meters are generally placed on large consumers, and the city can afford to furnish them free. Where meters are placed on private houses the revenue would be insufficient to pay for the meter before it might require renewal or repairs. In such cases the consumer should be charged with the cost of the meter, which should remain the property of the city."

G. J. Baker, Superintendent Meters, Chicago, Ill.:

"The consumer should be the owner, leaving it with the owner of a building supplied by small pipes as to whether it will be controlled by meter or not.

I also find that the ownership makes a great difference in the payment of meter repair bills, the owner of a private meter, as a general rule, pays repair bills promptly, while the party having use of city meter objects to paying for repairs on city property."

M. L. Holman, Water Commissioner, St. Louis, Mo.:

"I am of the opinion that the water meter should, in all cases, be owned by the water department for the reason that the repairs can be made at less expense and more rapidly, and the meters generally can be kept in better condition."

J. Nelson Tubbs, Chief Engineer, Rochester, N. Y.:

"I am clearly of the opinion that the water meters should be owned by the water department and not by the consumer.

The cost of the meters should be regarded as a part of the expense of the construction of the water works system, and the consumer should be charged such rates for use of water as will cover and include the annual cost of interest, depreciation and management of the meter for each service in the system. I claim that in the determination of the schedule of water rates to be charged in the management of a particular water works system, that the foregoing items relating to meters are as fairly an element of charge against the consumer as is the interest, depreciation and cost of management of any other part of the system such as pumping engines, pipes, hydrants, etc., etc.

The meter being the only fair way in which to sell water and the only way in which no overcharge will be made to one class, and no giving away water to another, the assumption should be in fixing rates that all services must be eventually metered.

Therefore as water departments, and especially private companies do not usually intend to expend money and do business for fun, they should furnish and own meters, and the consumer should bear the cost in the adjustment of rates.

Of course in addition to this, the consumer should pay for the repairs directly, when required, in consequence of carelessness, or malicious injury on his part."

John Caulfield, Secretary of Water Works, St. Paul, Minn.

"This is a question I have often considered, and I have not as yet fully made up my mind as to which is the best, but I lean more to the department owning them, as it saves a vast amount of wrangling with the consumer when ordering him to purchase one and then by making him keep it in repair. This is a subject I should like to see discussed. Either has its advantages and disadvantages.

In St. Paul there are four hundred meters. All, except four or five, are owned by the water department. Our plan so far works very satisfactorily. When we decide to put on a meter we make consumer prepare his premises so that the meter will be safe from frost, and if it should freeze or be damaged we charge the expense to consumer. We also charge rent for meter sufficient to pay interest on cost and wear and

tear. We put but one meter on the block on main supply, and if owner of block desires more on the branches to measure certain tenants, we compel him to furnish them at his own expense and do his own collecting.

If the consumer supplies his own meter the department should decide the different makes allowed and the repairs should always be done by the department, but at the consumers expense."

John R. Todd, Registrar, Norfolk, Va.

"In my opinion the consumer, for the following reasons: 1st. It is to his interest to have the meter cared for and kept in order. 2nd. It relieves the department of a large expense for repairs, etc., and is no hardship on the consumer.

I think, however, the department should have entire control of meters, make all repairs, etc., at consumers expense; and plumbers should not be allowed to interfere with them in any way.

In order to help the consumer to bear this expense our department allows on return of meter (after being overhauled and repaired) a credit for its full value payable in water."

B. D. McConnell, Superintendent Water Works, Montreal, Canada:

"I am of the opinion that the department should own all the meters. One reason is the greater facility for repairs when needed, or for testing, should it be thought advisable. In either of these cases if the consumer owns the meter, it is difficult to make him take the requisite steps promptly, and when he does the city must supply temporarily a substitute for the meter to be operated upon, and must change again when the repairs or test are completed, thus doubling the cost of the change.

Again if a better meter than those in use is introduced and adopted by the department, the consumer who owns his meter will be very slow to make the change."

E. L. Dunbar, Superintendent Water Works, Bay City, Mich:

"My opinion is firmly established that the meter should be owned by the department, based upon the following reasons:

It is generally acknowledged, I believe, that the proper and just manner of supplying water is by meter measurement. Such being the case, the question is, how shall it be done in the most economical manner to the consumer, and return the proper revenue to the department. The meter can be furnished, set and kept in repair by the department for less money than it can be done by the consumer. In many cases if the cost of the meter were added to the cost of introducing the water, the expense would be so largely increased as to be burdensome to the consumer, and without doubt in some cases would prevent the introduction of the water.

If the meter was the property of the consumer it would be a constant source of annoying controversy between the inspector and consumer, the consumer by right of ownership assuming a certain amount of control over it, its location and care, which the inspector could not concede except to the detriment of the interests of the department, and of the consumer himself. If the meter was the property of the consumer it would be necessary for the department to attend to the repairs and care

of them, as if left to the consumer in many cases the repairs would only be done under compulsion and then at heavy cost, as the average plumber would desire no more of a bonanza than looking after a few meters.

My experience is that most of the repairs to meters can be made in a very short time by persons familiar with their construction, and who are making those repairs in the interests of their employers, and under supervision which requires a strict account of the nature and amount of time required for certain work, knowing that the consumer would have to pay the bill, it would not be done with the same economy. The keeping of the accounts for repairs and the collection of the bills would add materially to the labors of the office and become a source of annoying controversy with consumer.

In view of all the facts, the right of control on the part of the department should be undisputed. The meter can be furnished and set by the department without any burdensome charge to the consumer, and it will receive more careful and intelligent treatment if owned and maintained by the department than if furnished and kept in repair by the consumer.

The meter should be owned and maintained by the department, the consumer being charged a minimum rate sufficient to cover the investment and the cost of supplying the minimum quantity of water required for the premises. Any injury caused by wilful neglect, gross carelessness, or intentionally done should of course be paid by the consumer."

Samuel M. Gray, Chief Engineer, Providence, R. I.:

"I think the consumer should own the meter. One strong reason why I think he should is, that he will be more apt to see that it is protected from the frost and accident, and will give it more watchful care to see that it is kept in proper order. He will also be apt to learn how to read it and look to the dial from time to time to see that there are no leakages of water on his premises. This often times prevents great waste of water which does the consumer no good and is a loss to the city.

Consumers usually have extravagant ideas as to the size of service pipe they should be furnished with, particularly for domestic services. They often want sizes twice or three times larger than is necessary, but when you show how much more the larger meter will cost than the smaller, they are more reasonable in their demands. Again, within a certain limit it seems desirable to allow the consumer the choice of taking water at fixture rates or meter rates, and under such circumstances it seems most just to have the consumer pay for the meter rather than for the city to furnish the same, and consequently be paid for directly or indirectly by taxation. Particularly when the consumer having the meter is supposed to derive the benefit from the use of the meter So far as I know the plan of the consumer paying for the meter has in all cases worked well. This seems to me a reason in favor for the consumer owning the meter. There are doubtless other reasons which do not occur to me at present."

John C. Chase, Chief Engineer, Wilmington, N. C.

"I am so thoroughly of the opinion that the department should

own the meters that I should expect those having a different opinion to set up their claim before entering upon any argument.

Briefly, I consider the meter a necessary part of the plant. I know of no other case where a purchaser is obliged to maintain the instrument which measures his purchase. Furthermore the department can repair, replace, etc., its own property with much less trouble than it can compel someone else to look after theirs.

Again, if the consumer buys an improved meter that, after due trial, the department wants to suppress, another element of contention comes into play. I think of no other reasons at this time." But consider the above weighty ones.

William Ryle, Vice Pres. and Sup't of the Water Co., Patterson, N. J.

"As Superintendent of a private company, do not favor the plan of metering dwellings. For manufactories should advise the company to own the meters as it would be a poor company that could not make the rate per thousand gallons enough to pay for the meter in five years, and yet sell the water at a low rate.

As we have 6,200 consumers and not one of them metered am afraid that I am not an authority on meters."

W. J. Milner, Sec'y and Sup't Water Co., Birmingham, Ala.

"My opinion is that the meter is properly a part of the Water Works system and should be so dealt with. It gives the Water company a better control of the supply, and there seems to me to be as much fitness in requiring a water company to furnish meters as there is in requiring a water company to furnish a reservoir and pumping engine. Further, it is more economical to the public for the water company to furnish the meter and keep it in repair without any corrresponding loss to the water company, if the company, as we do here, charge a small rental for the use of the meter.

The aggregate cost to the consumers of keeping meters in repair would be far greater than the amount of rental that would probably be charged by the water company. But the water company, by having as they usually do, and would necessarily have to do, a man whose business it was to do this, can do it a great deal cheaper and more satisfactorily, both to the water company and to the consumer."

B. F. Jones, Sup't Water Works, Kansas City, Mo.

"I should say that it depends upon circumstances. It is safe to say that the ownership should be in the person, or corporation wanting a meter.

There is certainly no justice in the company furnishing a meter where a small quantity of water is wanted or would be used, and I am of the opinion that our rule upon that subject is about the correct thing. It imposes no hardship upon anyone.

Rule 7.—The company reserves the right to set meters whenever there is any doubt as to the quantity of water used or wasted, and the consumer has the right to take water by meter measurement, when the supply is a permanent one, upon furnishing an improved meter, but in no case shall any meter owned by the company return less than two dollars per month. Parties desiring meter rates in preference to regular rates will pay the cost of meter and placing the same, and the minimum

rate will be seventy-five cents per month, when the supply is by meter the company will require a deposit sufficient to cover the estimated use for two months."

A. H. Martin, Sup't Water Co., Knoxville, Tenn.

"I think the department should be the owner.

1st.—Because the department dictates the kind of meter to be used.

2d.—Because the department makes all repairs, keeps the keys to the meterbox (if it is boxed) and allows no one to meddle with it, not even the owner.

3d.—It is the measure used to show the quantity of goods you sell to the consumer. If you go to the grocer to purchase a quart of vinegar, you are not expected to bring a quart measure with you to measure it with.

4th.—Most water departments have a tariff of annual rates, and when dissatisfied with the quantity of water used by the consumer, may put on a meter at its own expense, to check the waste, but cannot compel the consumer to pay for it.

Meters are expensive machines, and require a large amount of money to be invested in them when generally used, but may be made a source of profit by charging enough for the water to cover all expenses of extra labor for reading and repairs, and for interest on the money invested. In my opinion the only true way to sell water, is by measure, and if meters were universally used, there would be much less water pumped, and consequently much saved in the running expenses of water works."

Harry Birkinbine, Chief Engineer Water Co., Council Bluffs, Ia.

"I believe the Water Company should own meters and charge annual rental, say twenty per cent. of cost. They are apt to get out of order and it is not always easy to get consumers to consent to repairs. If the works own them they can be removed and replaced or repaired without consulting anyone. I believe meters should be tested and it is hard to get counsumers at all times to agree with the management."

Edward Ruger, Chief Engineer Water Co., Omaha, Neb., by W. F. McCue:

"My experience as Superintendent of several water works has taught me that it is far better for the Company to own the meters. It is the only way you can control them. Your meters can be of one make. If the consumer owns the meter, you will find that they all have different ideas about the best one in use. When they think the meter is registering too much they are very apt to meddle with it without consent of the water company.

The rule we have adopted with all our works, is, if we furnish and set meter, charge the consumer from twenty-five cents to four dollars per month rental, we keep meter in repair."

J. M. Randall, Vice-Pres't Water Co., East Orange, N. J.

"With what experience we have had with water meters, I am of the opinion that the department owning the water supply should own and set their own meters, then they have an undisputed control of them.

If we had a perfectly reliable and durable meter, it would be less

important, but even then it would be better in my estimation, to be owned by the department. If in doubt of a correct record, the right to repair or change the same is important to the department.

All water furnished to consumers should be by measurement. But how we are to arrive at a constant and corrrect measure, is an important question."

L. C. Burnes, Sup't Water Co., St. Joseph, Mo.:

"My opinion is that the consumer should own the water meter. And the only argument I have heard against it was by a gentlemen who compared the charging for a meter by the water company to a huckster compelling every purchaser of a bushel of garden truck to buy a bushel measure. But he admitted that if a measure was furnished with each bushel of truck the huckster would either add the value of the measure to the vegetables or charge outright for the measure.

The economical consumer gets sufficient advantage in the reduced water bill to justify him in paying for a meter. A wasteful consumer does not deserve it."

Richard Holme, Secretary Citizens Water Co., Denver, Colo.:

"In my opinion and from my experience in the business for the last twelve years, the water company should own and control the meters by all means.

First.—In order that the company may say what kind of meter to use.

Second.—In order that the company may have full access to the meter to repair, replace, examine, etc.

Third.—The property to be used being owned by the company, the mode of measuring should be controlled by it."

Chester B. Davis, C. E., Chicago, Ill.:

"I prefer the plan of the ownership being vested in the department since it facilitates making repairs or renewals and of making a fixed charge for use of meter."

G. W. Pearsons, C. E., Kansas City, Mo.:

"Only one item in the maintenance of meters can well come upon the consumer; first cost, and not knowing how small a part that really is he will be dissatisfied with the small reduction practicable in his bills.

Take a small house meter,—say it cost $20.00 to put it in, and with repair bill lasts ten years, all the consumer can save by owning it is, say twenty cents per month or less. The maintenance, reading, and extra labor of making and collecting bills, falls on the company and is at least double this.

The company or city owning the meters find by trial those giving the best general results. But few kinds are used and their care or interchange is comparatively easy. The individual owner may or may not know which is the best. It may be well for the trade and junk shops, but is hardly likely to be appreciated by those who have the care of them.

The idea of minimum meter rate is not generally properly given to the public. Many families, outside of leakage and sprinkling, do not use fifty gallons per day,"

Col. William Ludlow, U. S. Engineering Corps, Detroit, Mich.:

"By 'department' I understand the control of the water works plant by the city, leaving out of consideration ownership by a private company.

The water meter has two functions; first, to form an accurate basis for water bills in proportion to service rendered; and second to reduce waste by restricting the amount of water taken to what is really needed. The use of meter therefore should be advantageous both to the city and to the citizen. It is unfortunate that the cost of reliable meters is so considerable as to involve a large expenditure in the first place for their general application. Were it not for this, I should without hesitation, decide that the city should in all cases furnish the meters at its own cost. It is important, in order to take full advantage of its register, to see from time to time that it is registering correctly. Meters vary considerably in this respect according to their details of construction and the character of the water passed through them,—even the best will occasionally fail. They therefore should be subject to frequent examination, and the management should be such as to provide for preliminary test, for regular inspection, and for immediate replacement or repair in case of obstruction or failure. All this could be satisfactorily done only by city employes, and the repairs made in the city shop. Otherwise I apprehend that the repairs would not get themselves made and the service would fail of its value. On the other hand, the cost of the full equipment of meters is so considerable that it suggests the possibility of relieving the situation to the extent of permitting the consumer to buy the meter, the sum involved being in a single case not so great as to be prohibitory; but if this arrangement be made, it probably would be best to follow the example of the gas companies in many places, who furnish the meter and keep it in order, charging the consumer with the cost price until such time as he shall relinquish its use or the premises are transferred to other ownership or control.

On the whole, I should say that the water department should unquestionably own and control the water meters, if by any means the finances of the city are in such a condition as to permit of their purchase. This could be done by gradually adding a certain number each year until the equipment is complete."

Thos. J. Whitman, C. E., St. Louis, Mo.:

"My view of the question is just the same as given years ago to the municipality, viz.: The law should be,—

First.—In any case where the city superintendent of water works believes that the city would be better off and the revenues increased, that the city superintendent of water works should have the right to put in a meter, of course, such meter to be owned by the city, and taken care of, repaired and kept in perfect working order.

Second.—If any party taking water thinks or believes that the water tax, as assessed is excessive, then I believe that said water taker should have the right to put in a meter at his own expense to measure the water used, he to pay the entire cost of meter, and its setting and all needed repairs thereto.

Third.—No meter should be allowed to go in except such as are thoroughly approved by the superintendent of the works.

These three conditions being observed, I fail to see when and in what way trouble could arise."

Peter Milne, Hydraulic Engineer, New York City:

"I would say that being the property of a water company their control is better qualified, as to location and use, also as to access. The company would simply permit their use to determine the quantity of water used. Rules and regulations can be better enforced. Of course, you must keep your property in repair. Again, less opposition would be encountered if the water taker felt that he was not obliged to pay for the meter.

In brief, my opinion is, that any water company when they find the use of meters desirable, to abridge waste and save pumping ought, for economical reasons, to calculate the cost and maintenance of meters as a part of their construction and maintenance account. My experience was limited to municipal administration and I encountered opposition to a somewhat restricted meter system principally because meter takers objected to paying for cost of meters!"

J. D. Cook, C. E. Toledo, Ohio.

"Having given the matter some thought, I have a theory relative to the proper ownership of meters which I have brought to the attention of some of my clients.

I have recommended that the water department should own and control the meters, charging the consumer a small rental, sufficient for instance to pay the interest on their cost, attention and wear, and even to the extent of making the meter account a little profitable. The water department taking entire charge of furnishing and setting the meters, without any trouble or expense to the consumer except the rental. Any inspection or unsatisfactory performance of the meter to be reported to the Secretary or superintendent, who should immediately instruct the meter inspector to visit the premises, examine and correct the meter of any slight imperfection, or remove it to the shop and place a new or perfect meter in its place. The one taken out to be repaired and held in readiness for use elsewhere when necessary. The meter inspector, by making regular or frequent visits to premises would also be useful in detecting unauthorized use of unmetered water, unnecessary waste, etc.

I believe that this or some kindred arrangement would result favorably to both water authorities and consumers, giving better service than is ordinarily realized, and that the rental would cost the consumer less in the long run than to own the meter and look after its repairs."

Phinehas Ball, C. E., Worchester, Mass.

"In all cases those who own the franchise, pipes, gates and hydrants should own the meters, or they should form a part of the plant of the water department, for the following brief reasons:

First, the department can change the size of the meter of a particular consumer from a smaller to a larger size, or from a larger to a smaller as experience in use may prove best, and no questions asked.

Second, the department if it own the meter has perfect control of all needed cleaning or repair at its own option freed from a controlling dispute with the consumer.

Third.—There is no good reason why a consumer of water should

be required to furnish the measure by which the quantity he consumes is determined, any more than the man who buys coal, should be required to furnish the scales by which the amount he orders is determined or weighed."

Colonel J. T. Fanning, C. E., Minneapolis, Minn.

"In view of the fact that when a measurement of the water consumed from any particular service pipe is desirable, it is rarely the consumer that demands the meter, and also that as generally facts show that it is the department that insists upon the meter measurement, keeps the record of measurements, assumes the accuracy of the measurements, and who can most easily and at lowest rates of interest procure the relatively larger capital invested in meters, I have usually advised that the department provide, set and care for the meters, controlling them absolutely as their own property and charge for their use a fair percentage on their costs, as remuneration for interest and maintenance."

It will be noted from the foregoing replies that "doctors will differ." Singularly enough we find that the manager of the municipal works using the greatest number of meters in this country, about eight thousand, unquestionably favors ownership by the consumer, while the manager of a private company with over six thousand consumers and not a single meter, favors department or company ownership. Another strange fact will be noticed. Many of the arguments advanced on either side are identical. The advocate of department ownership gives as a reason "on account of the facility with which renewals and repairs are made."

The advocate of consumer ownership sustains his proposition with precisely the same argument.

Some of the replies concur with the arguments presented last year, that the meter is, and should be considered, part of the plant. This, however, in the opinion of the writer, does not obtain. If it does, then should the same argument be extended to the corporation cock, the service and the curb stop with equal force; all of which are more intimately connected with the plant than is the meter? The argument that the department, or company ownership offers greater advantages in the way of care of the meters, repairs, changes and renewals, is doubtless true, but the same premises are equally correct in the ownership of the pipe, hydrant, faucet and every other house fixture, were they all the property of the water company or department and cared for as we are expected to care for the meter, there would be no wrangle with the consumer in regard to leaking fixtures and waste of water, consequently there would be no necessity for the meter, and the subject matter of this paper wholly uncalled for.

The similes of the coal dealer and the scales, and the grocer and quart measure, like the huckster and bushel measure, are very "far fetched," and are in no wise analogous to the case. Were it possible to make one meter do the measuring for all the consumers, as is the case with the tradesmen above cited, or did the consumers come to the pumping station with their pails, bath tubs, etc, it certainly would be the height of folly to ask each one to purchase a meter and carry it with him, but unfortunately for the force of the argument upon that side of the question such is not the case.

The meter when placed upon the service of a consumer is there

for his exclusive use. The water company or department can make no other use or disposition of it any more than they can of his service pipes or fixtures. It becomes part of the consumer's individual system of supply, and should be paid for and maintained by the consumer. The general rule obtains with water supplies that they furnish the water to the consumer at the main pipe laid in the street, from which point it is conveyed by him, or through pipes laid at his expense, to such places of use as may be most convenient or desirable, and such fixtures attached as may be most suitable to his requirements, over all of which the water company, or department exercises the right of control, vested in it by the laws of the state under which it is incorporated. This holds as a fact whether the supply be under municipal control or be furnished by a private corporation operating under a franchise. The supplier has the right to demand that such pipes, fixtures, etc., shall be of a standard and approved make, and to demand that they be kept in proper repair or refuse to furnish water through them. This can be, and is, accomplished without wrangle with the consumer. It is true the consumer is frequently dilatory about making necessary repairs, and that he must very often be urged to promptness by attaching a meter, but usually the judicious use of the street key and a charge of one dollar or more for the trouble you incur will bring about equally good results.

The consumer having the meter is the party directly benefitted from the fact that by its use, in nine cases out of a hundred, his water rate will be from twenty-five to fifty per cent. less than under the ordinary tariff rates. For example:—An average dwelling of seven or eight rooms with bath, lavatory, and closet, is ordinarily rated at from fifteen to twenty dollars per annum. Assuming it to be occupied by a family of six or seven persons, the actual quantity of water used will be less than one hundred gallons per day, or about thirty thousand gallons per annum. This quantity at thirty-five cents per one thousand gallons, will aggregate ten dollars and a half. The average rate for a horse is two dollars per year, and he will drink not to exceed eight gallons per day, or one dollar's worth of water in a year. This same ratio of meter to schedule rates will hold good throughout the tariff sheet, unless there be persistent and wilful waste. In fact it is only to prevent such waste that meters are ever demanded by the water department. If then the consumer can only be kept honest, for it is dishonesty to willfully waste or destroy the property of another, by the use of a meter, he should be compelled to pay the price of his integrity. If he is to reap a profit in the way of reduction of rate he should assume the investment.

In the opinion of the writer, the consumer should pay the cost of the meter and its setting, as well as all subsequent repair. The supplier should have full and undisputed control, should direct where it should be set, and exercise the right to dictate the kind and size to be used, and should regularly test it for accuracy. If repair be necessary, insist upon its being done promptly. As a matter of policy the supplier should adopt certain standard make, or makes, of meter, and permit none other to be used. He, or they, should purchase all meters direct from the manufacturers, and set the same, charging the consumer only net cost. This will prevent the intermeddling of the plumber, who, as a rule, does not furnish anything except at a profit, if he knows it.

It is also well for the company or department to keep a limited number of meters for rent, charging an annual rental therefor, of at least

twenty-five per cent. of the cost of the meter and its setting, to meet that class of migratory consumers found in every community who have no assurance of remaining longer than a year or two.

Every meter should be made with all parts interchangeable and should be so constructed as to be repaired easily and quickly in situ. The company keeping in stock duplicate parts so as to be able to replace those defective without removal of the meter.

The rule adopted by the writer in the works under his charge is the same as that quoted by Major Jones of Kansas city, and he believes it to be wholly equitable. Where the consumes desires the meter grant him the privilege at his own expense, provided he will agree to pay a minimum rate. Where the company is satisfied there is wilful waste or fraudulent use of water, place a meter and charge a rental therefor. His present practice is to charge a monthly rental of, for five-eighths inch, fifty cents; three-fourths, or one inch, seventy-five cents; one and one-fourth inch, one dollar; larger sizes in like proportion; and finds the system to meet with favor.

THE SECRETARY: I have here two papers bearing on this subject by W. G. Richards and Thomas J. Neville, and a newspaper clipping handed me by Mr. Gardner. As these papers are quite long and our time very short, I move that they be printed in the proceedings, as discussion on the foregoing paper, without being read.

Motion seconded and carried.

RESULTS OF A GENERAL METER SYSTEM.

The city of Atlanta supplies no water to consumers without a meter, and there is no rate but a meter rate. The only exceptions are the city offices, public schools, police headquarters, fire engine houses and the public drinking fountains.

The causes which lead to a general use of meters are about the same as cause their use elsewhere. They were put on to stop a waste that could be controlled in no other way. Previous to their introduction a house to house inspection was made, and many places were shut off until leaks were stopped and defective fixtures repaired. The waste had become so great that the machinery was run down in the effort to keep a satisfactory pressure. The pumping main was not of sufficient capacity to deliver the quantity required without such a loss from friction that it was found to be impossible to obtain a satisfactory pressure in the event of fire, many consumers complained that the water did not flow in the upper floors of their dwellings and business houses, the merchants complained of a lack of pressure for their elevators, and last, though the greatest complaint, came from the fire department who were compelled to use the fire engines to get the required pressure for fire streams, this last caused a general increase in the insurance rates, all these things combined brought out quite a number of newspaper articles, and a sort of general public dissatisfaction.

This was about the state of affairs when the Board of Water Commissioners applied to the General Council for an appropriation of funds

with which to purchase a new pumping engine and another main pipe. The City Charter limits the rates of taxation to one and a half per cent except in a case of emergency, in which event the tax rate may be increased to two per cent. The funds were not on hand and could not be raised without an increase in the rate. The General Council thought, or said that the Water Board should declare the emergency and the Water Board said no! We have called upon you for the money for our department and if you have not got it, it is for you to declare the emergency and procure the funds from the taxes. Knowing how unpopular such a move would be, the Council declined to put on the additional half per cent. and there looked to be a pretty bad state of things ahead for the water department. As a last resort the Water Commissioners decided to try what effect meters whould have in stopping the waste. There were at this time, in 1883 but 1663 service connections and the average daily pumpage was 2,379,283 gallons. The income for this year was an average of $18.64 from each connection. On the first of April, 1884, the Board passed a resolution requiring all manufacturing establishments, hotels, boarding houses, bar-rooms, barber shops and all consumers other than private families to put a meter upon the supply pipe passing into their premises, and it was found at the close of this year, 1884, with 1832 service connections, the pumpage was 3,137,761 gallons per day, an average to each service of 1712 gallons; this satisfied the Board that the principal waste was among private families, and in March, 1885, they passed a law requiring every water consumer to put in a meter by July 1st. This met with much opposition from the citizens generally, and also from the General Council, but as before stated the Council having refused to provide the funds for the purchase of additional pumping machinery, they were finally convinced that the meter system was the only alternative and allowed the Water Board to carry out the resolution. There was from various causes a good deal of delay in getting all the meters in, and in cases where the consumer furnished to the water office a certificate from a plumber, showing that a meter had been ordered, the water was not cut off, but the meter rate took effect on July 1st, and parties were charged for the back months in accordance with the first months consumption after the meter was put in. It was not until about the close of the year 1885 that all consumers were provided with a meter, consequently the report of 1886 must be taken as showing the result of a general meter system, however, it will be observed there was at the close of 1885 a marked decrease in the pumpage. There were in 1885, 1983 services and an average pumpage per day of 2,400,000 gallons which shows a consumption on each service of 1211 gallons, being 501 gallons per service less, and a saving of twenty per cent on the pumpage of 1884. At the close of the year 1886 there were 2077 service connections, and the pumpage per day averaged 1,575,400 gallons, a falling off of 824,600 per day, and an average pumpage to each service of 759.4 gallons. For the year 1887, we find 2192 service connections and that the pumpage was 1,721,858 gallons or about 786 gallons to each service. Comparing the pumpage of 1883 and 1887 it will be seen that there was pumped 643 gallons less to each service during the latter year than was pumped when there were no meters in use. In the year 1888 the daily pumpage was 1,718,391 gallons and the number of services 2461 or 698 gallons to each service connection. For the year 1889 we report 2,073,320 gallons pumped per day, to 2879 services, an average to each service of 720 gallons. It

will be seen by a comparison of the pumpage of 1883 with that of 1889 that there has been a saving of more than 50 per cent in the pumpage to each service.

It would be difficult to form an estimate of the water used by the public buildings and schools, for flushing sewers, for supplying eight over-flowing public horse troughs, and the extinguishment of fires, but if these services were deducted from the daily pumpage, I am of the opinion that the average supply to each service would be very moderate. The pipe distribution—cast iron main—is about a half mile to each 1000 of population and as the distribution is extended the average pumpage to each service will be less for the reason that the business houses, hydraulic elevators, hotels, railroads and larger consumers will not increase in proportion to the number of domestic or small consumers.

The income of the present year will not fall short of $60,000 from 3000 services, an average of $20.00 a year from each service or an increase of 7¼ per cent from each service since a general system has been adopted.

In the income there is nothing estimated for hydrants, or for public schools, and other city buildings and public supply. The city has never allowed the water department any credit for this service.

I use the word pumpage or pumped, because ours being the direct pressure system these terms are more applicable.

The number of meters April 1st was 2630. The pumping machinery is now in every respect as good as when new.

W. G. Richards.

PAPER ON METERS.

Assuming that this Association has for its end and aim an interchange of views on the actual experience of its members, representing cities in the several states, interested in all matters concerning water supply, and feeling that it is a duty to give such information as will tend towards the improvement of methods and management of water departments, I beg the privilege of contributing a word in relation to the method or system of determining the manner of making rates for consumers of water.

Some fourteen years ago the citizens of Rochester, New York, commenced using water which flowed by gravity from its source of supply, a natural reservoir, situated something over 300 feet above the level of the city, in such great volume, and with so much pressure that it might have been said that it forced an entrance into our houses and premises, and fought for its right of way and the privilege of occupation against sewer contaminated wells and receptacles that were filled by the storm water which washed the roofs of our buildings. The supply was then abundant for the 65,000 people, which was estimated the city had, and the water was used with lavish hand for many unnecessary purposes. It flowed freely on demand without effort or labor, and became a plaything for the populace. Rapidly the consumption was increased, and the water board thought it expedient to introduce meters on premises using large quantities, in order to ascertain where the vast amount of water was going, as well as make those obtaining such a supply pay for it. This policy met with disfavor, and it was considered an unwarranted abridgement of the rights of the citizens to interpose any guardian or protector of the city's interest on them. From extravagant waste to

prudent economy is a step averse to the natural propensities of our nature. Gradually against protest after protest the officials attached meters to all services supplying water for business or commercial purposes. It was soon learned that thousands of gallons of water were used where hundreds would be sufficient, and the consumer who could not be induced to repair leaky or defective fixtures, or who wilfully wasted the water, found it to his financial advantage to stop the leaks as well as the waste, and, that after all, the meter was an agent to save him expense as well as a means to avoid the annoyance resulting from the adjustment of charges against him for water.

This experience was given to others, and the last eight years the demand for meters has increased, and to-day the citizens are asking that meters be placed on their premises, and are impatient at delay in complying with their demands.

Like other cities, Rochester introduced the estimated rate plan, and like other cities maintains it to-day. Before the invention of meters such a scheme was, perhaps, the only one that could be devised, but I see no justification for its longer existence, as it was never more than a guess method, and is not entitled to any higher honor to-day. To illustrate what I deem its absurdity, I may cite how this method is applied to Rochester. The owner of a lot fifty feet front is charged $3 for a hose attachment or a street washer, $2 for a bath tub, and $2 for a water closet, while the charge for all his other uses is based upon the assessed valuation of his property. This is grossly absurd, because what known relation can there be between the valuation of property and the quantity of water consumed? Then, again, the use of water for bath tub or closet depends on the number of persons in the family, and the humble cottage may consume twenty times as much water per year as the occupants of a millionaire residence. The system is not only absurd, but unjust and unequitable.

Some cities charge according to the number of faucets, and if you enjoy the luxury of more than one in your house an additional charge is made, just as though any family will not obtain all the water wanted through one faucet as well as if it had ten. Other cities base their schedule rates on the frontage of buildings or lots, the number of stories high, or some other ridiculous way. I can only account for the fact that people tolerated this arbitrary manner of collecting water rates, because they had to have the water, no matter how much inequality and injustice was done them in paying for it. What seems surprising is that the rates for consumption of water were not based on the number of bricks in the building, the size of the windows, or the height of the chimneys.

All taxes are not justly levied, and, perhaps, because of human fallibility, never will be, but the water department should not plead this excuse, as an instrument for measuring water is in existence.

Meters are now so perfected as to approximately register the number of cubic feet of water used, and if the manufacturers will persist in obtaining still greater perfection, they will prove themselves the best friends of the water consumer, and appreciated assistants of water departments.

After an association with our water department of fourteen years, I am of the conviction that the meter system is the only one to adopt for these reasons :

First. That use of meters saves water and therefore postpones the day of vast expense for the extension of your system of water supply.

Second. That the citizen pays for the amount of water he consumes, and not for a quantity some engineer or clerk imagines or supposes he consumes.

Third. That the burden of taxation for works and maintenance of water systems is justly distributed according to the benefits received.

Fourth. That calculated, estimated or guess rates based on a supposed water consumption were never, are not now and never can be equitable, just or honest. THOS. J. NEVILLE.

GAS METRE ACCOMMODATION.

The Gas Company Entitled to Rental for its Metres When Gas is Used as an Auxiliary.

Judge Fenner, as organ of the Supreme Court, has rendered the following decision in the case of the Harmony Club vs. The New Orleans Gas Company. The decision in the lower, or District Court, was in favor of the defendant, the gas company, whereupon the plaintiff asked for an appeal to the Supreme Court. It has been refused by the latter in the following decision:

Harmony Club vs. New Orleans Gaslight Company.—Appeal: We are confronted with a challenge to our jurisdiction, *ratione materia*, over this appeal, which we are bound to determine.

The facts are simple and undisputed. The Harmony Club had upon its premises, furnished by the gaslight company, what is called a 45-light meter, adequate to the supply and registry of all its gas burners. In common with many other gas consumers, it adopted the system of electric lighting, and its use of gas became only occasional and greatly reduced.

The gas company adopted certain rules applicable to this class of consumers, the meaning and effect of which are that it would only furnish meters proportioned in size to the amount of gas consumed. That a "45-light meter" would only be supplied or continued, when the monthly gas bill was $8 per month, or if less upon the payment of an extra rental of $4 per month.

A copy of these rules was served upon the club, and notice was given that unless complied with, its meter would be removed and replaced by a smaller one.

The club being unwilling to comply and denying the right of the gas company to adopt or enforce such rules, instituted this suit for an injunction prohibiting the latter from removing or interfering with the meter then upon its premises. The gas company responds affirming its right to adopt and enforce the rules in question. This is the sole issue involved in the case. If it should be determined that the gas company has the right to adopt and enforce the rules, the injunction necesaarily falls. If *per contra*, it has no such right the injunction stands.

What is the amount of pecuniary value involved in such a suit?

It is not pretended that the gas company will interfere with the meter if the club consumes gas to the amount of $8 per month, or if consuming less, it pays $4 additional for the rent of the meter.

It is not denied that the club is bound to pay for the amount of gas, large or small, actually consumed by it.

Therefore, the only value possibly involved is the right of the company in a certain contingency, to charge $4 per month for the use of its meter, or $48 per annum.

If this were a right *in perpetuus* it would be difficult to find an investor who would pay $2,000 for the privilege of collecting $48 per annum.

But in point of fact the gas company's charter expires in thirty-five years, and a simple calculation would show that if collected during that period the gross amount would not exceed $1,700.

Moreover the club is not the owner of the building, but a lessee, and is only interested during the term of its lease, the extent of which is not shown, but is presumably limited.

We are not concerned with the damage which the club might have suffered had its gas supply been cut off or diminished, as threatened. No such damages have accrued or will accrue.

If the injunction herein be perpetuated that will prevent such injury. If it be dissolved the act of the gas company will be declared lawful and no such claim can arise.

We have repeatedly held that the jurisdiction of this court must be tested in such cases by the pecuniary amount of value in dispute according to the nature of the action as disclosed by the substantial allegations or affidavits of the parties.

Buddig vs. Baldwin, 38 Ann., 394; State ex rel. vs. Miscar, 34 Ann., 834; Wilkins vs. Gault, 32 Ann., 929; Crean Case, 32 Ann., 1191.

Most of the cases quoted by appellant only concern the right to sue and to enjoin, neither of which rights are controverted here.

We decline to follow him into the records in the cases of Callory vs. Waterworks Company, 35 Ann., 799; Kovy vs. same, 36 Ann., 942, and Ernst vs. same, 39 Ann., 551, in order to determine whether or not we had jurisdiction in those cases. The opinions show that no such question was raised or passed upon. Had it been we should have applied to them the same rules now stated.

If inadvertently and in absence of suggestions to that effect, we exercised jurisdiction which we should have declined (which we by no means admit), such error neither harms nor benefits the plaintiff here, whose right must be decided according to law.

It is therefore ordered that this appeal be dismissed at appellant's cost.

MR. TUBBS: This paper by our worthy President opens one of the most imminent questions that has been presented to this Convention. It is sprung upon us at this late hour. There are other papers awaiting action and I wish to say that while I admire the ingenuity and the enterprise of our President in procuring this information, I totally differ with him in his opinions, the resultant opinions, and I desire metaphorically to take off my coat and go for him. There are other gentlemen who will sustain him and other gentlemen who will agree

with me, and for so important a question there is no time remaining in which it can be properly discussed. It is one of the great questions of the day as to whether meters shall be used at all, by whom they shall be furnished and by whom paid for. Now, we have but one hour in which we can use this room and I therefore believe that this question should be left over until the next meeting of the Convention. In the meantime these papers can be read. They will all be presented to you in the annual report and then the members may prepare themselves for the discussion, and we shall have an intelligent one, and we shall come very near settling the question and all the vexed questions in the matter. I therefore move that this discussion be now closed and that we immediately proceed with the final election of officers and the determination of the place for holding the next Convention. I would like to add to my resolution that the papers remaining unread after passing the criticism of the committee, be put into the annual report without reading.

Carried.

MR. TUBBS: I now move that we proceed to the election of officers, and that the report of the Chairman of the Nominating Committee be now received.

MR. MILNE: The Committee on Nominations for officers of the American Water Works Association unanimously report the following names of officers for the ensuing year:

PRESIDENT—William B. Bull, Quincy, Ill.

VICE-PRESIDENTS—First, G. H. Benzenburgh, Milwaukee, Wis.; Second, Joseph A. Bond, Wilmington, Del.; Third, J. L. Lyman, Lincoln, Neb.; Fourth, R. N. Ellis, Jacksonville, Fla.; Fifth, H. F. Dunham, Cleveland, O.

SECRETARY AND TREASURER—J. M. Diven, Elmira, N. Y.

FINANCE COMMITTEE—J. P. Donahue, T. J. Melville, William Molis.

MR. TUBBS: As one of the members of the Nominating Committee, I have no apology to make for the nominations presented. If they do not commend them-

selves to your intelligent judgment, the power is in your hands to make new ones. Now in the line of promotion, is this elegant southern gentleman, Mr. Richards, of Atlanta. It would have done me proud to have presented his name to this Convention, as its coming President. He is entitled to it by every consideration of justice and tradition and everything of the kind, but I have to say for Mr. Richards that he came to the committee and begged it not to present his name to the Convention; that he loved this Association more than he loved William G. Richards. We have presented these names, and in justice to Mr. Richards this is said. I can say the same thing for Mr. Diven, my friend and neighbor, but we all love our Association more than ourselves, and whatever we can do to make a great national Association of it, that we are willing to do at the sacrifice of anything else.

Mr. Donahue: I move that the report of the Nominating Committee be adopted and that the Secretary be instructed to cast the vote of this Convention for the nominees.

Carried.

Vote of the Convention cast for the candidates of the Nominating Committee, and Messrs. Cameron, Gardner and Tubbs were appointed a committee to escort the new President to the chair.

The President: With extreme pleasure and gratification, I yield to you the gavel which has been wielded in this tenth Annual Convention, the most successful one ever held, and my only hope is that you may eclipse this one as far as the Tenth eclipsed the others.

Mr. Bull: Gentlemen, I suppose on an occasion of this sort it is customary for a man to express his surprise, and I think you will believe me sincere when I say that no action on your part could have brought a greater surprise to me than the one you have just taken. They say that lightning strikes in unexpected places sometimes, but if, when I arose this morning I had been told that I should be struck by lightning before night, I should not have been more surprised than to know that I should be

called upon to preside over the deliberations of as large and respectable Convention as the one in session. I can not accept this action on your part as any tribute to my special merit or fitness to this place, for I cannot in candor say that I possess them, and I attribute it to the kindness of the committee which nominated me, for I understand that you gentlemen of the Convention had very little choice in the selection of your President. If the matter came up in a competitive form I am sure that I should not now be addressing you, but I recognize the kind feeling which has placed me on this platform, and I beg of you a continuance of that same feeling and that you will overlook any mistaken judgment on my part on account of my ruling, my rulings if mistaken will at all events be prompted on my part by fairness. There is one thing that I desire to say before I take my seat, and that is, a constitutional deformity which is something like color-blindness, so that I cannot call or associate names and faces. I am just as liable, if Mr. Tubbs gets up, to say that Mr. Donahue has the floor, or if Mr. Darling that Mr. Linneen is entitled to the floor, as anything else, and I beg of you that in the numerous instances of that sort which may happen, that you will overlook them and if I forget the names of my best friends when they come on the floor, I beg of you set it not down in malice.

Mr. Decker: Gentlemen of the Association, I simply desire in a few words to thank you for the manner in which you have borne with me in my frailties and in my rulings and also for the manner in which you have so ably assisted in carrying out the object of this Convention. As I stated in the closing part of my address, I had confidence that the gentlemen would stand by me in this respect and I thank you from the bottom of my heart for having done so.

The Convention next proceeded to the selection of a place for the next annual convention. Philadelphia was placed in nomination by Mr. Diven, Omaha by Mr. Linneen, St. Louis by Mr. Dudley and Washington by Mr. Sickles. The claims of Philadelphia were advocated by Messrs. Diven, Kelly and others. Omaha was championed by Mr. Linneen, and Washington by Messrs.

Sickles and Monjeau. After the close of the discussion the Convention proceeded to ballot and Philadelphia was chosen as the next place of meeting, after which the Convention adjourned.

EVENING SESSION, Friday, May 23, 1890.

Convention called to order by President Bull.

THE PRESIDENT: While we are waiting for the report of the Committee on Badges I want to thank Mr. Ryle, if he is in the room, for the badges he has so kindly furnished us. Mr. Ryle certainly deserves the hearty thanks of this Convention.

Motion made that a vote of thanks be extended to Mr. and Mrs. Ryle for their kindness in presenting the Association with badges, carried.

MR. DIVEN: Your committee have submitted a design for a badge and I think most of the members have had an opportunity of seeing it. The Executive Committee have recommended that the design be adopted.

Motion that the badge be adopted as the official badge, carried.

Motion made that invitations received from various Chicago dealers in water works appliances be placed on file, and their receipt be acknowledged by the Secretary.

Carried.

To the Honorable Members of the Water Works Association Convention, Grand Pacific Hotel, Chicago:

GENTLEMEN:—Will you kindly allow us to extend to you and your friends in attendance to the convention, an invitation to view our system of burning fuel oil as it is being operated by the Phoenix Distilling Company. It is but a few minutes ride and will not detain you long. Anytime most convenient to yourselves will be suitable to us. Transportation on the North Chicago Street Railway will be furnished to all upon application to our representative in attendance.

Very respectfully yours,

INTERNATIONAL GAS & FUEL CO.,

E. T. WILLIAMS, President.

To the Honorable Chairman of the Tenth Annual Convention of the American Water Works Association:

DEAR SIR.—The process of transforming water and electricity from a natural state to a condition of utility, and the methods of Commercial distribution are so greatly analogous, that one cannot fail to recognize that a close kinship must soon follow in the commercial conduct of those two most important factors in the World's progress.

The many new processes of electrical generation, the instruments and apparatus used in connection therewith, and the methods employed in the practical workings of this industry, may be of interest to many attending the Water Works Convention.

The writer will take pleasure in showing to any such, the Central Electric Light Company's station and instrument equipment at No. 185 Dearborn street, Adams Express Building, and also give any information relating to the business that may be desired.

Very truly,

JAMES E. KEELYN.

THE SECRETARY: The following resolution was handed to me by somebody:

Resolved, That the active members of this association note with pleasure the very creditable exhibits of the manufacturers and dealers in water works appliances made at this meeting by our brother associate members, and we do especially mention in this connection the beautiful display made by the Thompson & Houston Electric Company, which has afforded pleasure to the lady members of our association as well as to ourselves.

MR. PRESIDENT: There are some unread papers which it may be your desire to hear read if the opportunity is presented. There are papers from Mr. Denman, Mr. Lakin and others, and those papers have not as yet been read by the writers.

MR. TUBBS: While I regret extremely that these papers should not have been read before the convention, yet at this late hour it seems too late to have them read and properly considered. I understand that Mr. Denman's paper is a work of great merit; a paper in which he invested at least four weeks of time, a paper that will be invaluable to water works people everywhere, not only the members of this association, but all people who are interested in water works. It is legal in its character, and we can best consider it and best understand it when it is printed and laid before us. Now I respectfully ask permission to move that Mr. Denman's paper and all others still unread be spread upon the minutes of the Association, and that opportunity may be given at the

next annual convention to discuss them fully. I know that Mr. Denman's paper is one of such value and such intricacy that we could not give it any general discussion to-night, and therefore I offer this resolution.

Mr. Cameron: At our last meeting there was a discussion about giving the technical papers the right to publish these papers before our annual report came out. Our Secretary at that time, Mr. Decker, was under the impression that it would not do; that we ought to furnish the papers in the reports. If the technical papers can have these papers I think it would be a very good idea because we could read them while they are fresh in our minds. I would like to suggest if it is in order that these technical papers who will take the trouble be allowed to have the papers.

The Secretary: I think every technical paper has been furnished with these papers.

Mr. Linneen: I want to say a word on this question of papers. It seems too bad that men who have been asked to prepare papers for these meetings and men who have devoted a great deal of time and some expense to a proper consideration of the subject treated, who come from a distance to our meetings, should not have an opportunity to read their papers, but that these papers should be pigeon-holed. Now a great deal of the time of this convention, Mr. Chairman, has been dissipated to some extent in talk, and I contributed considerable of that talk myself.

Mr. Tubbs: True.

Mr. Linneen: I trust that this will not happen again. It is very discouraging to gentlemen who have put a large amount of time upon these papers to go away from the meeting without hearing them read, and if our Asssociation continues to multiply as it has, it has occurred to me that all papers submitted at our meeting, after they have passed the scrutiny of our executive committee, should be discussed at the next meeting.

The President: I will say gentlemen that I accept the suggestions offered by Mr. Linneen, and am fully

aware that our deliberations on this occasion have not progressed as rapidly and satisfactorily as they should have done. I am satisfied that it will be the unanimous sense of this convention that in our next convention we will have business first and pleasure afterwards.

A motion made that the Secretary be requested to make application to the authors of those papers for them that they may become the permanent literature of this organization. Carried.

MR. CAMERON: I offer the following resolution:

Resolved, That a vote of thanks be tendered our Local Committee of Arrangements for their most elegant conception of what should be an entertainment for a Delegation, and the happy carrying out of the same. Not forgetting the Ladies of the Local Committee and the many kind attentions shown by them to the Ladies of the Convention.

Amendment that a copy of above resolution be sent to each member of the commitee.

THE PRESIDENT: I suggest that the Secretary send an engrossed copy of these resolutions not only to the members of the committee, but to their backers, the associate members who have stood by them so well and put their hands so deep in their pockets. (Applause).

MR. SAFFORD: In behalf of the members of the American Water Works Association I think we owe a vote of thanks to the proprietors of the Grand Pacific Hotel for their courteous treatment of us during our session here, and I move that the chair appoint a committee of three to bring Mr. Parker personally before us that we may offer such thanks. Carried.

The President appointed Messrs. Safford, Tubbs, and Linneen to bring Mr. Parker before the bar of the Assosociation.

MR. SEVIER: I am a new member and don't want to appear conspicuous and don't want to come all the way from Arkansas for the purpose of offering any suggestions which might be considered by some as perhaps impertinent. I have found here a body of representative men from different sections of our country and it seems that the magnitude of this convention and the work before it and the dignity that it should be possessed

of, would indicate a rule by which certain laws of etiquette and decorum should be followed. I notice that in this legislative body we have continually during even our sessions of business activity, continued smoking, and I would suggest, not as a menace, or as a matter of impertinence, but it is within the province of this convention now, that some rule may be adopted about this matter so that at our next annual meeting, during the business sessions of this legislative body, smoking may be dispensed with. I offer this as a resolution.

Mr. Tubbs: I expect before the next session of this convention to so amend my habits that I shall not desire to smoke during the session of the convention. The gentleman is correct about it. I believe it is a total disregard of the proprieties for gentlemen during the session of the convention to smoke. If he wants to smoke he had better go outside, and I have smoked probably more than anyone else in the convention.

Mr. Rumsey: I speak very feelingly in regard to this matter for the reason that I am aware and know positively that when Mr. Denman's name was repeatedly called to read his paper he was not present because it was impossible for him to stay and live in the room. He so stated in those words, that he could not live there, and no money would hire him to remain in the room.

Mr. Sevier: As the mover of that motion I make an extenuation that is necessary. I smoke myself and dearly love a cigar, but in dignified bodies that attract the attention that the American Association of Water Works people attract I feel we should forego that indulgence for a while, because it adds more to the dignity to the Association. There is no reason why the rules that apply in the halls of Congress and in our Legislatures should not apply to an Association of this kind.

Mr. Kelley: I move as an amendment to that resolution that the members be *requested* not to smoke during the discussion of papers, and that notice to that effect be placed in the meeting room by the Secretary at our next annual meeting.

Motion lost. Original motion lost.

MR. GARDNER: If in open session Mr. Denman or any other gentleman should request the members of this Association to refrain from smoking, while he was in the room, I should cordially and quickly abandon my cigar. I am willing to accord that in the spirit of courtesy to anyone who approaches me in that spirit.

THE PRESIDENT: I think Mr. Gardner has settled the whole thing in a nut shell when he says that he, as a gentleman, is willing to accord in the spirit of courtesy anything to anyone who approaches him in that spirit. I am satisfied that the members of this convention when they realize that there is a strong feeling opposed to the indulgence in tobacco will yield to that feeling and refrain from indulging.

At this point Mr. Parker was brought before the meeting and amidst continued applause, the resolution thanking him for his courtesy was read to him, to which he responded.

MR. PARKER: I thank you very much, gentlemen; I am not too full for utterance, but this thing is rather unexpected, and more than I am prepared for. I am not a member of this association, and am not posted on water works, but I think I know as much about water as most of you.

MR. GARDNER: I move that the heartfelt thanks of this Association be tendered to Ex-President J. H. Decker, for the able and impartial manner with which he has discharged the duties of the presidency for the past year. I move the adoption of the resolution by a standing vote.

MR. DECKER: I made a remark I think on the first day of this Association that any officer of the Association who did his duty was not entitled to thanks. We owe this duty to ourselves and to the members of this Association. Consequently, I am not entitled to any thanks; but I thank you for your kind expressions.

MR. TUBBS: If this is a debatable resolution I totally differ with Mr. Decker. It is one of the hardest things for a man to do his duty and his whole duty. I believe Mr. Decker has done it and if you can give any

man encouragement by a vote of thanks I say do it. I second the resolution most heartily. Carried.

Mr. Linneen: This meeting has passed a very complimentary resolution here thanking this local committee for their feeble efforts in the plan they have mapped out for your entertainment at this tenth annual meeting. Now, Mr. Chairman and members of this convention in behalf of that local committee let me express the thanks of the committee to this convention for the large attendance and the courtesy shown us and the attention paid to all our little requirements in our endeavor to make your stay here pleasant and agreeable. I also want to publicly thank the gentlemen and firms who so liberally contributed to the fund which we had in stock to make this entertainment what it has been, and I approve very heartily the President's suggestion that the Secretary officially thank those contributors. Now as Mr. Decker says he has simply done his duty and I feel here to-night that this committee have simply done their duty, and I believe that this convention has appreciated our efforts in the courteous resolution passed by them, and that is all the thanks that we want. I shall be happy to meet with you again and the committee next year. (Applause).

The President: This our tenth annual meeting seems to be drawing to a close. I think we shall bear nothing but the happiest recollections of the convention. So far as I know not a single unfortunate or marring or jarring incident has occurred. It has been one uninterrupted round of pleasure from beginning to end. I think all the members of the convention should feel that they have an individual responsibility in making a success of our next convention. If any member has any idea to communicate let him do so to the Secretary or Chairman, that he may be given an opportunity to speak or may hear from those who will speak on subjects of interest to him.

Mr. Kelly: I would move you that the Secretary send out a notice to all the active members of the American Water Works Association, requesting them to present some subject that they would like to hear discussed at our next meeting or on which they would like a paper

written, and that all such suggestions and requests be submitted to the Executive Committee, that they may select what in their judgment they deem for the best interests of the organization.

Carried.

The Secretary: Personally I owe a great deal to Mr. J. P. Safford for his kind assistance. I make this resolution that the thanks of the Secretary and the Association be tendered to Mr. Safford.

Carried.

Mr. Tubbs: Everybody has been thanked almost, but there are some parties still remaining. I call the President's attention to some of them. A few of us were invited to visit the new tunnel and I hope the President will express our thanks to the gentlemen who were so kind to us.

The President: I owe an apology to Mr. Tubbs as he called my attention to the fact that Mr. Onderdonk, the contractor of the new tunnel and his superintendent, who has extended very unusual and gratifying compliments to members of this association, be included in the resolutions which we have offered early in the evening.

Carried.

Mr. Linneen: Mr. Chairman, and gentlemen of the convention, I think that a great deal of the success which has characterized our meetings in the past, has been largely due to the attendance of the ladies at our convention. It is a feature of these gatherings that should commend itself to us and it is a feature that should be encouraged; that men who have wives and sisters should be encouraged to bring their wives and sisters with them. I move you that the Secretary of this organization be instructed to write a personal letter to each one of the ladies that have attended this meeting, and thank them in behalf of this organization for their attendance, and that he express the wish of this convention that they attend the next meeting.

Adopted.

Mr. Linneen: It is well to be banded together in this way. The American Water Works Association has gone abroad in the land; here I believe is the first application we have had for a suitable man to fill the position of superintendent of water works, by a financial firm, who are largely interested in the construction of works. Here gentlemen is the communication addessed to us as a body.

Mr. Tubbs: I move that this application be referred to the Executive Committee of this Association, and I hope the gentlemen will respectfully consider the merits of the speaker for that position.

Mr. Cameron: I think the representatives of the press ought to have a vote of thanks and I most respectfully recommend that they be thanked for their attention and courtesy.

Carried.

The Secretary: I wish to have the stenographers included in this. I wish personally to thank the stenographers for the very prompt copy which they have furnished. I have now in my possession the report of all the proceedings, including the banquet last night. Everything except this meeting to-night has been furnished me. It is all in my hands ready for the hands of the printer.

The President: I understand that is something unprecedented in the history of this association.

Adjourned.

J. M. DIVEN, Secretary.

THE EXHIBITS.

The very creditable exhibit of water works appliances shows a rapidly growing interest in this, comparatively new, feature of our conventions. This is only the third year that any special effort has been made to induce manufacturers and dealers to exhibit their specialties at our meetings, and the large and well lighted room was filled to overflowing with exhibits including almost everything needed in the construction and management of water works, and the walls were hung with drawings and photographs of articles too large and heavy to exhibit.

In addition to this exhibit the Thompson and Houston Electric Company had a room fitted up with electrical appliances manufactured by them and brilliantly lighted with their incandescent lights.

Anthony P. Smith, through the courtesy of the Chicago Water Department, gave a practical exhibition of his machine for making large connections with water mains without shutting off the water, making a 6" connection with a 12" main.

The attention which the active members gave to the exhibits, between the sessions of the convention, shows that they appreciate this feature, and that it is one which should be encouraged.

Among the exhibitors were the following:

Galvin Brass & Iron Works	Detroit. Mich
Bourbon Copper & Brass Works	Cincinnati, Ohio
R. D. Wood & Co	Philadelphia, Pa
E. H. Kellogg & Co	New York
J. B. Clows & Co	Chicago
Eddy Valve Co	Waterford, N. Y
Ludlow Valve Co	Troy
H. Muller	Decatur, Ill
Fisher Governor Co	Marshalltown
Illinois Malleable Iron Co	Chicago
Hersey Meter Co	Boston
Union Meter Co	Worcester
National Meter Co	New York
Thompson Water Waste Prevention Co	New York
Western Valve Co	Chicago
H. R. Worthington	New York
Gordon Steam Pump Co	Hamilton, Ohio
Deane Steam Pump Co	Holyoke, Mass
Northwestern Rubber Co	Chicago
Tuerk Hydraulic Power Co	New York
Spiral Weld Tube Co	East Orange N. J
National Tube Works Co	McKeesport, Pa
Walter S. Payne	Fostoria, Ohio
A. W. Morgan M'f'g Co	Buffalo, N. Y
Jarvis B. Edson	New York
Isaac B. Potts M'f'g Co	Columbus
Hayes M'f'g Co	Erie, Pa
J. L. Mott Iron Works	New York
Rouse & Hills Co	Cleveland, Ohio
Rensselaer M'f'g Co	Troy, N. Y

THE TECHNICAL PRESS WAS REPRESENTED AS FOLLOWS:

Engineering News by .....George H. Frost and J. P. Safford
Fire and Water by.....F. W. Sheppard and DeWitt Stevens
The Engineering and Building Record by.....Frank W. Skinner
The Sanitary News by.....J. B. Burtt
The Engineering and Mining Journal by.....W. T. Moffatt
The Western Fireman.....———
The American Engineer.....———

"THE SOCIAL FEATURE."

In making the report of the Local Committee of Arrangements, Chairman Linneen said: "The Local Committee of Arrangements have provided what *they consider a very pleasant programme* for the entertainment of the members of this Association," and so say we all of us.

While the members were in attendance at the regular sessions and attending to committee work, etc., the ladies of the Association were being very pleasantly cared for by the ladies of the Local Committee.

Wednesday afternoon, through the courtesy of Mr. Webster, H. R. Worthington's, Chicago representative, the Association and its guests were shown through the "Auditorium," and all were provided by the same gentlemen with tickets to the observatory, to be used at their convenience, and nearly all availed themselves of this opportunity to view the various proposed World's Fair sites, thus saving two or three days valuable time and many miles journeying.

Thursday afternoon the Association was taken in charge by the Local Committee and taken in carriages to the Harrison street and North Side Pumping Stations, and for a drive through the beautiful Lincoln park and along the Lake Shore drive to a pier on the north shore, where we embarked on tugs for a trip to the North Side and Fourteenth street tunnels. On the return an exhibition was given by the powerful fire boat "Geyser." An exciting race between the boats composing the fleet and the Geyser was a feature of this trip. On landing carriages were in waiting to convey us back to the hotel.

With appetites sharpened by the afternoon trip the members and guests assembled in the main dining room which had been elegantly decorated for our annual banquet, which, this year, was provided by the Local Committee assisted financially by the following voluntary contributors to banquet expenses and other entertainments:

American Filter Co.
Allis, E. P. & Co.
American Tube & Iron Co.
Ashton Valve Co.
Babcock & Wilcox Co
Blatchford, E. W. & Co
Bass, J. H. & Co.
Bingham & Taylor.
Bogue, O. A.
Chapman Valve Co.
Crane Co.
Hazleton Tripod Boiler Co.
Hersey Meter Co.
Illinois Malleable Iron Co.
Jones & Laughlins, Limited.
Kemper, A. C.
Lahman, W. H.
Ludlow Valve M'f'g Co.
Leonard & Izard Co.
McDonald M'f'g. Co.
Mott Iron Co., J. L.
Morgan & Co., A. W.

Clow, J. B. & Son.
Deane Steam Pump Co.
Detroit Pipe & Foundry Co.
Drake, Parker & Co.
Davis, C. B.
Eddy Valve Co.
Elmes, Chas. F.
Ft. Wayne Jenny Electric Co.
Gordon Steam Pump Co.
Gray, C. E. Jr. & Co.
Goodsell, B. W.
Holly M'f'g. Co.
Hughes Steam Pump Co.
Harris, N. W. & Co.
Mueller M'f'g. Co., H.
Municipal Investment Co.
National Tube Works Co.
Northwestern Rubber Co.
National Meter Co.
Porter Boiler M'f'g. Co.
Rhodes & Ramsay Co.
Raymond Lead Co.
Rumsey, I. P.
Tuerk Hydraulic Power Co.
Thompson Houston Co.
Wolf M'f'g. Co. L.
Western Valve Co.
Worthington H. R.
Wood & Co., R. D.

After a sumptuous and perfectly served banquet had been thoroughly discussed, President Bull called the assembly to order, and in a few well chosen words introduced the toast master, Mr. C. M. Foote, who delivered a brief but appropriate address, and in his usual happy manner called for the toasts on the programme, which were responded to as follows:

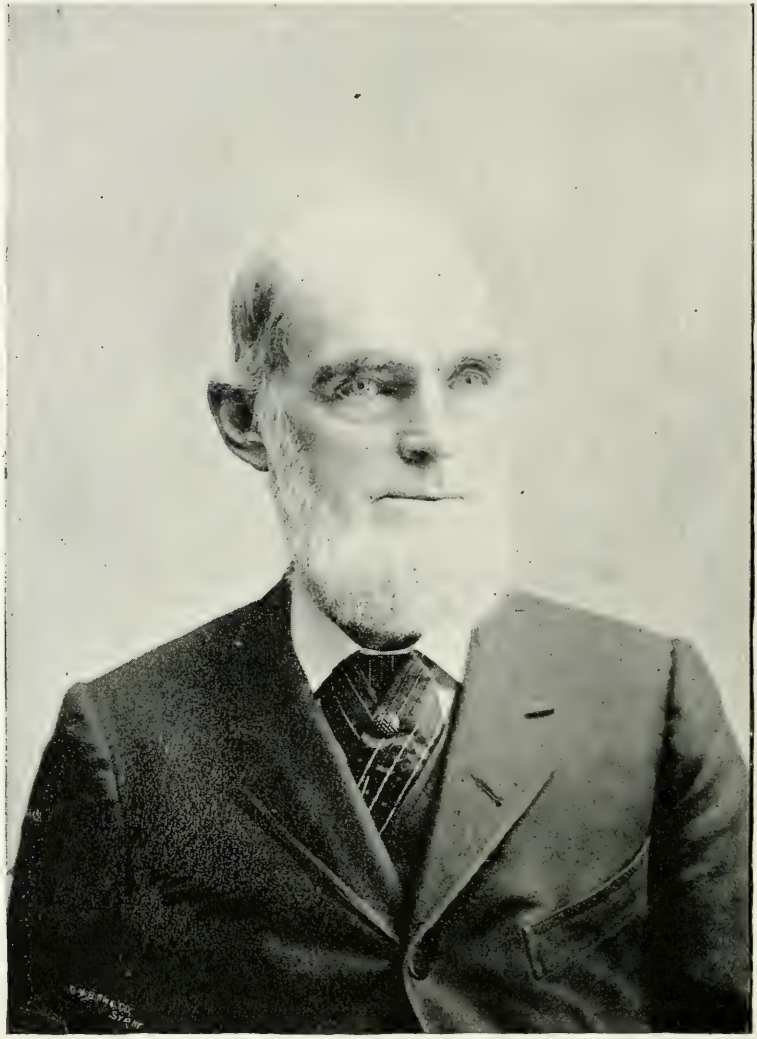
City of Chicago, by.....Hon. Wm. J. Bulger
Water Department of Chicago, by.....Mr. W. R. Northway
New England Water Works Association, by.....Col. James R. Lyon
Our Absent Friends, by.....Mr. J. Nelson Tubbs
Our Associate Members, by.....Mr. J. A. Tilden
Water, by.....Mr. W. G. Richards
Scientific Progress in the manufacture of Water Works Supplies, by.....Mr. P. H. Linneen
The Social Features of our Annual Banquet, by.....Mr. J. C. Kelly
Our Homes, by.....Col. L. H. Gardner
Woman, by.....Mr. A. F. Callahan

The toasts were interspersed with music by the "Imperial quartette" of Chicago, nearly all of the selections being so well appreciated that encores were demanded. After the toast to woman the quartette sang "Good Night Ladies," after which the ladies withdrew. Then Mr Donahue, who, on account of his great modesty and bashfulness had been excused during the presence of the ladies, responded to the toast "Original Packages in Iowa," after which cigars and a general free and easy good time was enjoyed till a late hour.

Friday morning a special train on the Illinois Central railroad was provided by the American Filter Co., and under the guidance of Mr. Rumsey the Association were taken to Elgin, Ill., and through the celebrated watch works there.

After lunch, by another special train, we were taken to Pullman where attendants provided by Mr. Pullman, were in waiting to take us through the works and show us the other features of this celebrated city. The return was made by special train to South park, thence in carriages through South Park and Jackson Park drives to the hotel via Michigan avenue.

In commenting on "The Social Feature" the order of "71" and its great help in creating a sentiment of good fellowship and brotherly love in the Association must not be forgotten.



J. G. Bissell

In Memoriam.

JOHN G. BRIGGS,

MECHANICAL ENGINEER, INDIANAPOLIS, IND.,

DIED MAY 6TH, 1890.

**"Invidious Grave! How thou dost rend in sunder,
Whom love has knit and sympathy made one."**

JOHN G. BRIGGS was born in South Dedham, Mass., February 16th, 1828, where he was reared and received his early education. In the breaking out of the "gold fever" in '49, he fell a victim to the contagion and spent ten years on the Pacific coast in vain pursuit of that fickle goddess whom so many wooed but few won.

At the commencement of the war he was in Boston, Mass., and enlisted in the 13th Massachussetts Infantry, serving with his regiment one year when he was transferred to the Navy and assigned to the Missisisppi Squadron, where he served with credit until peace was declared and he received an honorable discharge. While at home on leave of absence, July 26, 1864, he married Miss Mary Heiskell, of Jeffersonville, Ind., who yet survives him. Of this union, one child was born, on September 20th, 1870, but which died June 25th, 1871.

After the war he became a member and superintendent of the firm of Anders, Heiskell and Co., lumber dealers and manufacturers of sash, doors, etc., at Jeffersonville, Ind. Upon severing his connection with this firm he went to South Bend putting in machinery for Studebacker Bros. Manufacturing Company.

In 1873 he located in Terre Haute, taking charge of the water works in that city before their completion; he filled the position of engineer and superintendent for this company until the close of 1888, when failing health compelled him to resign. To his ability and unflagging energy is due the popularity and success of that company, his management of affairs was highly appreciated by the stockholders and directory, and his leaving them occasioned the most kindly expressed regrets as well as the highest commendations for future service.

He was also designing and constructing engineer of the Paris, Ill. water works, built in 1879, and the Greenville, Ill. works built in 1884.

After leaving Terre Haute, he again went to the Pacific coast in hope of regaining his health, but was disappointed and returned to Indianapolis, Ind., where he has since made his home. He then essayed to travel for one or two firms, but rapidly failing health prevented any close attention to business. Soon after the appearance of La Grippe, he was seized with that dire complaint from which he never rallied until called hence by the Great Engineer of the Universe. His love for, and fealty to his chosen profession, was unceasing, continuing through his last rational moments.

MR. BRIGGS was one of the earliest movers in the formation of this Association. At the organization in 1881 he was elected Vice-President and at the Third Annual Meeting, held at Buffalo, N. Y., in 1883, was made President. He was always most enthusiastic in its support; ever ready to assume any duty assigned him and prompt and fearless in its discharge: a man of quick and ready wit, but dry and quaint in his humor, large hearted and genial in his intercourse with his fellow men, he was repected and beloved by all who knew him.

FINANCIAL STATEMENT.

1889.				Dr.	Cr.
April 16,	Balance cash on hand,			$23 08	
"	P. J. Morrett, fee			5 00	
"	Jas. H. Wilkinson,	Fee and Dues to	1890,	8 00	
"	R. T. Race,	"	"	8 00	
"	Jno. Barnett,	"	"	8 00	
"	Edward Ruger,	"	"	8 00	
"	Wm. Reinecke,	"	"	8 00	
"	Muscoe Burnett,	"	"	8 00	
"	Emil C. Geyelin,	"	"	8 00	
"	F. W. Jackson,	"	"	8 00	
"	A. H. McAlpine,	"	"	8 00	
"	C. M. Foote,	"	"	8 00	
"	Isaac B. Potts,	"	1892,	13 00	
"	Jno. A. Cole,	"	1890,	8 00	
"	H. P. Martin,	"	"	8 00	
"	A. J. Guilford,	"	"	8 00	
"	F. G. Barrows,	"	"	8 00	
"	A. F. Callahan,	"	"	8 00	
"	L. D. Day,	"	"	8 00	
"	Wm. L. Clark,	"	"	13 00	
"	Bourbon Brass & Copper Works,		"	13 00	
"	Water Waste Prevention Co.,		"	13 00	
"	Fisher, Governer Co.,		1889	8 00	
"	Jno. A. Colwell, Fee		"	10 00	
"	A. L. Brown,	Dues to	1890,	3 00	
"	Geo. Reyer,	"	1889,	12 00	
"	Philip Morley,	"	1890,	3 00	
"	R. M. Jones,	"	"	3 00	
"	Galvin Brass and Iron Works,	"	1889,	3 00	
"	Wm. Oliphant,	"	1890,	3 00	
"	J. A, Bond,	"	"	3 00	
"	H. R. Worthington,	"	"	3 00	
"	Rouse & Hills Co.,	"	"	3 00	
"	J. B. Russell,	"	"	3 00	
"	Chas. Hood,	"	"	3 00	
"	H. E. Keeler,	"	1889,	3 00	
"	A. H. Martnie,	"	"	6 00	
"	W. G. Richards,	"	1890,	3 00	
"	Wm. Ryle,	"	"	6 00	
"	Geo. Hornung,	"	"	3 00	
"	Chas. N. Priddy,	"	"	3 00	
"	A. N. Denman,	"	1889,	3 00	
"	C. S. Brown,	"	"	3 00	

"	B. R. Morton,	Dues to	1890,	3 00
"	J. M. Diven,	"	"	6 00
"	Jno. W. Taylor,	"	"	3 00
"	W. S. Hamilton,	"	1889,	9 00
"	A. F. Kent,	"	"	3 00
"	H. G. Holden,	"	"	3 00
"	Wm. Molis,	"	"	3 00
"	Jos. E. Waltz,	"	"	12 00
"	J. T. Sawyer,	"	"	3 00
"	L. H. Williams,	"	1888,	3 00
"	F. W. Gerecke,	"	1890,	3 00
"	Jewel Pure Water Co.,	"	"	3 00
"	W. J. Milner,	"	1889,	6 00
"	Columbus Water Works,	"	1890,	3 00
"	Ludlow Valve Co.,	"	1889,	3 00
"	J. S. Walker,	"	1890,	3 00
"	Andrew Bergstrom,	"	1889,	6 00
"	J. W. Henion,	"	"	3 00
"	E. C. Cook,	"	1890,	3 00
"	J. B. Johnson,	"	1889,	3 00
"	B. F. Jones,	"	"	6 00
"	J. P. Donahue,	"	"	3 00
"	Frank Shefold,	"	"	6 00
"	Tuerk Hydraulic Power Co.,	"	"	3 00
"	A. G. Moore,	"	"	9 00
"	National Meter Co.,	"	"	3 00
"	W. L. Cameron,	"	"	6 00
"	W. B. Bull,	"	"	3 00
"	H. Mueller,	"	"	3 00
"	Aug. Schaeffer,	"	"	3 00
"	Frank W. Holly,	"	1890,	3 00
"	P. H. Linneen,	"	"	3 00
"	Holly Manuf'g Co.,	"	"	3 00
"	E. Darling,	"	1889,	3 00
"	A. W. Morgan Manuf'g Co.,	"	"	3 00
"	W. T. Harris,	"	1890,	3 00
"	W. H. Messinger,	"	"	3 00
May 7.	Ahrens & Ott M'f'g Co.,	Fee, and	"	13 00
"	W. J. Root,	"	"	8 00
"	Chas. Hermany,	"	"	8 00
"	J. H. Decker,	"	1889,	9 00
May 22.	R. B. C. Bement,	"	1890,	3 00
May 28.	W. T. Goodnow,	Fee and	"	8 00
June 6.	Howard Elmer,	"	1889,	3 00
"	S. E. Babcock,	"	"	3 00
"	Bingham & Taylor,	"	"	3 00
"	Eddy Valve Co.,	"	"	3 00
June 7.	J. D. Cook,	"	"	3 00
"	Hays Manuf'g Co.,	"	"	3 00
"	Jno. L. Ogden,	Fee and	1890,	8 00
"	Dean Steam Pump Co.,	"	1889,	3 00
"	Volker & Felthousen,	"	"	3 00
"	A. H. Howland,	"	"	3 00

"	R. D. Wood & Co.,	Dues to	1889,	3 00
"	Geo. A. Ellis,	"	"	3 00
"	L. E. Gray,	Fee and "	1890,	8 00
June 8.	Ohio Pipe Co.,	"	1889,	3 00
"	Whitney Conant,	"	"	3 00
"	B. F. Stephens,	"	"	3 00
"	J. Jas. R. Croes,	"	"	3 00
June 10.	Wilson Henderson,	"	1890,	3 00
"	Isaac S. Cassin,	"	1889,	2 00
"	H. D. Wood,	"	"	3 00
"	W. S. Kuhn,	"	"	3 00
"	J. T. Fanning,	"	"	3 00
"	N. Wingfield,	"	"	3 00
"	Chapman Valve M'f'g Co..	"	"	3 00
"	C. W. Morse,	"	"	3 00
"	F. A. W. Davis,	"	"	3 00
"	Dennis Long & Co.,	"	"	3 00
June 11.	Sylvester Watts,	"	"	9 00
"	J. L. Mott Iron Works,	"	"	3 00
"	F. L. Fuller,	"	"	3 00
"	L. H. Gardner.	"	"	3 00
"	Chatanooga Pipe Works,	"	"	3 00
"	Robt. K. Martin,	"	"	3 00
"	A. McCallum,	Fee and "	1890,	8 00
June 12.	Geo. F. Swain,	"	1889,	3 00
"	The Gordon Steam Pump Co.,	"	"	3 00
"	N. Kuhnen,	"	"	6 00
June 13.	J. M. Randal,	"	"	3 00
"	Walter Watson,	"	"	6 00
"	H. C. Heermans,	"	"	3 00
"	Ripley & Bronson,	"	"	3 00
June 14.	J. B. Clow & Son,	"	"	3 00
"	Geo. F. Blake M'f'g Co.,	"	"	3 00
"	Michigan Pipe Co.,	"	"	6 00
"	W. W. Sprague,	"	"	3 00
"	Jones & Laughlin,	"	"	3 00
"	J. N. Chambers,	"	1890,	3 00
"	H. W. Ayres,	"	"	3 00
"	Ezra Clark,	"	"	3 00
June 15.	Chas. B. Brush,	"	1889,	3 00
"	National Tube Co.,	"	"	3 00
"	D. C. Fry,	"	"	1 00
"	Hardwick & Ware,	"	"	3 00
June 17.	L. Halsey Williams,	"	"	3 00
"	R. Gervase Elwes,	"	"	3 00
"	F. W. M. Raeder,	"	"	6 00
"	L. J. LeConte,	"	"	3 00
"	Jno. Caulfield,	"	"	3 00
June 19.	Fred Adee,	"	"	3 00
"	B. M. Espey,	"	"	3 00
June 20.	Lake Shore Foundry,	"	"	3 00
"	Myron Wiltsie,	"	"	3 00
"	P. J. Neagle,	"	1890,	6 00

June 24.	J. C. Chase,	Dues to	1889,		3 00
"	Union Water Meter Co	"	"		3 00
"	Phinehas Ball,	"	"		3 00
June 25.	Edward H. Brown,	"	"		3 00
June 27.	L. N. Case, Fee and	"	1890,		8 00
June 28.	Schickle, Harrison & Howard Iron Co.,	"	1889,		3 00
"	M. L. Holman,	"	"		3 00
"	Fred Wing,	"	"		9 00
"	J. A. Tilden, Fee and	"	1890,		8 00
"	P. B. Perkins,	"	1889,		3 00
July 1.	Jno. R. Todd,	"	"		3 00
"	Norfolk Water Co., Fee and	"	"		8 00
"	Jos. E. Hannah,	"	"		3 00
July 6.	A. J. Jones,	"	"		6 00
"	Addyston Pipe & Steel Co.,	"	"		3 00
July 8.	Dan'l W. Mead, Fee and	"	1890,		8 00
July 11.	Philip Buehner,	"	"		6 00
July 22,	Chas. F. Loweth,	"	1889,		3 00
"	L. C. Burns,	"	"		3 00
"	Chas. A. Hague,	"	"		3 00
"	Wm. T. Porter,	"	"		6 00
August 8.	R. M. Gow,	"	"		3 00
"	Jno. W. Hill,	"	"		3 00
"	Edward A. Browere,	"	1890,		3 00
Aug. 20.	Harry G. Koch, Fee and	"	"		8 00
"	Lucien A. Taylor,	"	1889,		3 00
"	B. D. McConnell, Fee and	"	1890,		8 00
Aug. 24.	Wm. B. Sherman,	"	1889,		3 00
Oct. 9.	J. W. Troy,	"	1890.		3 00
Nov. 23,	Geo. H. Robertson,	"	"		3 00
"	Wm. Deutsch, Fee and	"	"		13 00
1890.					
Feb. 14.	W. H. Laing, Fee and	"	"		8 00
Feb. 17,	E. H. Bishop, Fee and	"	"		8 00
March 11,	Wm. H. Searls,	"	1889,		1 00
March 13,	D. M. Clark,	"	1890,		3 00
"	F. H. Pond,	"	1889,		3 00
March 31,	Hersey Meter Co.,	"	1890,		3 00
"	J. A. Tilden,	"	1893,		8 00
"	Sylvanus Ayres,	"	1890,		3 00
April 17,	Wm. Molis,	"	"		3 00
April 28,	Ill. Malleable Iron Co., Fee and	"	1891,		13 00
"	R. C. P. Cogeshall,	"	"		6 00
"	M. L. Andrews, Fee and	"	"		8 00
May 1.	D. C. Fry,	"	1890,		3 00
May 6,	Chester B. Davis,	"	1891,		8 00
"	R. A. Robertson,	"	1889,		3 00
May 15,	Timothy Woodruff,	"	1891,		6 00
May 16.	Isaac W. Brooks,	"	1890.		3 00
"	Sale Proceedings to date,				8 40

DISBURSEMENTS.

	Paid.	BY J. H. DECKER, PRES. AND PAST SEC.	Cr.	Dr.
April 16,	"	Postage & charges on books to Louisville,	$	1 00
"	"	Telegram,		55
"	"	Extra charges for room		4 00
"	"	For printing cards and tickets,		4 40
"	"	Porters,		50
"	"	For Hack,		1 00
"	"	For papers and postage,		85
"	"	For register and red ink,		75
"	"	For petty expenses,		1 60
"	"	Postage & express on books from L'sville,		1 00
May 2,	"	Envelopes for certificates,		25
"	"	Seal wafers,		25
"	"	Express charges on Proceedings,		40
"	"	Postage stamps,		2 00
June 3,	"	Postage stamps,		2 00
"	"	P. H. Linneen for plates,		8 00
July 15,	"	Postage on circular letters,		6 00
"	"	Express charges,		50
Aug. 1,	"	A. G. Welsher, printing circular,		6 35
Aug. 20,	"	Express charges,		50
"	"	Postage stamps,		2 00
Sept. 4,	"	Stenographer's report,		79 35
Sept. 10,	"	Postage stamps,		2 00
Oct. 1,	"	" "		50
Oct. 7,	"	A. G. Welsher, printing,		22 50
Nov. 22,	"	Registering badge,		10
1890.				
Feb. 8,	"	Postage stamps,		2 00
Feb. 18,	"	A. G. Welsher, for printing,		50
March 3,	"	Postage on electrotypes,		1 40
"	"	Express charges,		1 20
March 8,	"	" "		65
March 20,	"	Postage,		2 00
April 20,	"	Postage on Proceedings,		18 00
April 24,	"	Express charges,		20
April 26,	"	A. G. Welsher, printing Proceedings,		169 45
"	"	Express and postage on extra papers,		1 10
May 1,	"	Stationery,		1 30
"	"	Drayage on books,		25
May 10,	"	Postage on returned Proceedings,		12
May 17,	"	Drayage on books,		25
May 19,	"	" "		50
1889.		DISBURSEMENTS BY J. M. DIVEN, SEC'Y.		
June 1,	"	Postage and stamps,		8 00
"	"	Express on books from Salina, Kan.,		5 20
June 4,	"	" papers,		95
June 10,	"	" "		30
June 11,	"	Letter book,		90

1889.			Dr.	Cr.
June 13,	"	Elmira Telegram for stationery,		9 75
Nov. 11,	"	Postage stamps,		1 00
Dec. 27,	"	Advertiser Asso. for stationery,		4 00
1890.				
Feb. 10,	"	Postage stamps,		2 00
March 7,	"	Express on papers to Pres.,		45
March 17,	"	Elmira Advertiser Asso., notices, etc.,		11 50
April 7,	"	Postage stamps,		2 00
April 19,	"	Express on Membership ledger,		40
April 22,	"	Postage stamps,		5 00
April 30,	"	" "		10 00
May 2,	"	Express on books from Salina, Kan.,		1 15
May 3,	"	Postage stamps,		5 00
May 3,	"	Rebinding certificate book,		75
May 12,	"	Freight on annual reports,		1 95
May 15,	"	Elmira Advertiser Asso., programmes, etc.,		18 50
"	"	J. M. Diven, Sec'y's salary,		350 00
May 15,	"	Balance cash on hand,		129 91
			$965 48	965 48

UNREAD PAPERS.

The following papers which were on the program, but were not read owing to lack of time are, in accordance with a resolution here inserted in the proceedings, to be discussed at the next meeting. Mr. Denman's paper is being revised by him and will probably be presented at our next meeting :

"OUR EXPERIENCE WITH ARTESIAN WELLS."

J. T. LAKIN.

About ninety miles northwest of Chicago with an elevation above lake Michigan of 128 feet and above sea level of 708 feet, on the banks of Rock river running almost through its centre, is situated the city of Rockford, a place of about 25,000 inhabitants with a direct pressure system of water works, and forty-two miles of mains. It is the purpose of this paper to treat of its water supply and give you

"OUR EXPERIENCE WITH ARTESIAN WELLS."

The southern boundary of the collecting area from which our wells draw their supply is about sixty-five miles northwest of Rockford and its extent roundly estimated is about 4,000 square miles, it has an effective elevation of 270 feet above lake Michigan (although parts of it rise as high as 400 feet) and 850 feet above sea level.

In this area the Potsdam sand stone crops out at the surface. The difference in elevation between the two points is 142 feet and the Potsdam sand stone being entered by the drill about 500 feet below the surface at Rockford, shows that water bearing rock to have a dip of about 650 feet. Over this rock is a layer of magnesian lime stone 100 feet thick which being impervious confines the water to the lower rock.

Our first well was drilled 530 feet deep with an eight-inch bore, and flowed at the surface about 1,000,000 in twenty-four hours, the water raising by test twenty-eight feet above the ground. This showed a friction loss of 114 feet between the basin and the well, or about 1.75 feet per mile.

We continued the work of sinking wells and soon had four connected with the pumps whose combined flow was about 3,000,000 gallons per twenty-four hours, but this flow was not permanent and soon began to decrease so that about 2,500,000 gallons per twenty-four hours was the limit. At this time a paper mill situated one mile south of us on ground seventeen feet lower drilled a well which affected ours still more and we drilled one more, but our own supply did not improve to the extent we desired or expected, and an investigation showed that the No. 1 well was flowing at the surface only 70,000 gallons and at point of connection 210,000 gallons per twenty-four hours, and we decided to repipe and repack this well down through the upper stratas in the magnesian and note results. When finished the result was a flow of 177,000 gallons at surface and about 400,000 gallons at point of connection.

The same work on No. 4 resulted in an increase of from 142,000 to 254,000 gallons at surface with a delivery at point of connection of about 700,000 gallons in twenty-four hours.

We are now at work on the other wells, and the total benefit cannot be determined until all the wells are repiped.

We note that our wells were faulty in construction, this repiping shows conclusively that the wells were leaking badly in the upper stratas.

One well will under certain conditions effect another, those conditions in our case being a fine water bearing sand stone, causing too much friction, and elevation.

A multiplicity of wells of small diameter close enough together to make the conduit or suction of any value at point of delivery to pumps will interfere with each other to such an extent as to limit the supply, and if to overcome this interference the distance one from another is increased, the friction in conduit is so great as to overcome any gain on account of non-interference, this we demonstrate in our No. 5, that one being 700 feet distant from the nearest one of the other four.

The flow of our wells is not uniform, extremely dry weather for any length of time at the basin affects the flow, decreasing it gradually, and it is months frequently before we notice a return to normal conditions. These wells being all connected to one conduit and through the suction into the pit, are so arranged that any one of them can be piped out above ground and shut off from the main pipe and by so piping either one of the five, and continuing pumping from the other four we find that the highest the water will raise above ground is eight feet and this head will gradually lower as we increase the pumpage and lower the water in the pit, showing conclusively that we have more discharging capacity in the five holes, than the porosity of the sand rock will supply in the area in which they are drilled.

Artesian wells at Galena, Illinois; Dubuque, Iowa; and Prairie Du Chien, Wisconsin, all supplied from the same basin have a much stronger flow than ours, and investigation shows that at those places the Potsdam is much more porous, and in some instances delivers to the eight-inch hole more water than the hole can deliver at the surface, and we also find that while the area of the collecting basin is about 4,000 square miles only a small portion contributes toward our supply owing to the dip of the rock predominating toward the west and the southwest.

With this experience, then, we conclude that our supply of pure water is limited, until we devise a method of securing it in greater abundance, and plans having that end in view are now under consideration which, if carried out, will be made the subject of a paper later on if the Association so desire.

SOME OBSERVATIONS AND SUGGESTIONS CONCERNING WATER WORKS CONSTRUCTION.

F. L. Fuller.

Believing that every member of an association like this should be glad to do what he can to maintain its interests and efficiency, has led me at the request of our President, to offer a few thoughts for your consideration. I fully realize that there are many belonging to this organization who have had much greater experience than I, and whatever is here offered is freely open to their criticism.

THE WATER SUPPLY.

The first requisite of any system is, of course, an abundant supply of the best water. For supplies for small towns in the East, ground water from collecting, or driven wells, is being largely used. Stored in covered reservoirs or tanks it gives almost universal satisfaction.

THE PIPE SYSTEM.

The pipes forming the distribution system should be of sufficient size to furnish good fire streams. With this in view, six inch pipe is small enough except for short cross streets where there are no hydrants, or to connect what might otherwise be dead ends. If a pipe is a dead end and has no hydrant upon it, or has one only to be used as a blow off, there is this advantage in having it small, that less water is wasted in blowing it off, and the consumer gets fresher water than from a larger pipe.

If possible there should be none of these pipes with plugged ends, but every pipe should be part of a circuit.

The size of pipes could be much reduced if only domestic service were to be provided for. A fire of any size requires immense quantities of water to extinguish it, and this must be applied quickly in large volumes, and this requires large pipes.

HOSE AND HYDRANTS.

The recommendation of Mr. J. R. Freeman, in his valuable paper read before the American society of Civil Engineers of New York, and later, in a modified form, before the New England Water Works Association at Boston, that the size of fire hose be increased from two and one-half to three inches in diameter, is worthy of the most serious consideration. It seems perfectly feasible that all, except the few lengths nearest the nozzle, which may have to be used from a ladder, should be of the larger size. The tables given in this excellent paper show the great decrease in friction, due even to a slight increase in the diameter of the hose.

Of course this change would involve corresponding changes in the size of hydrants and hose fittings, but who that has watched the feeble streams thrown upon a great conflagration has not wished that they could be increased in force and volume. Increasing the size of hose for a part of its length at least, is, no doubt the most economical way in which this result can be secured.

Hydrants in the thickly settled parts of town should not be over 350 feet apart.

The loss from friction, especially in hose of the present size, is so great that a good head at the hydrant, or steamer, is soon lost in forcing

the water required for a good fire stream, through a few hundred feet of ordinary hose. According to Mr. Freeman's tables, the least friction found was ten pounds per square inch, and the greatest twenty-seven pounds in 100 feet of hose.

Both were two and one-half inches in diameter, the former being solid rubber, with "the interior free from ridges, and was intended to be smooth as rubber could be made." The latter was unlined linen hose.

When it is considered that even with the best hose, such as is referred to above, and which is probably better than that found in most fire departments, the loss is fifty pounds for 500 feet of hose, we see the advantage of short lines.

Mr. Freeman gives forty-pounds at the base of the play pipe, as the proper pressure to discharge 250 gallons per minute through a one and one-eighth inch smooth nozzle, and reckons it as a "good ordinary fire stream."

To obtain the same results with 500 feet of the best rubber hose would require ninety-five pounds at the hydrant or steamer. If the hose were such that there was a loss of twenty pounds in a hundred feet, to produce a stream of the same efficiency would require a pressure of 145 pounds at the hydrant or steamer. All of which goes to show that good fire streams are dependent on short lines of smooth hose.

Hydrants should be set, if possible, just off the supply main, or else there should be a gate on the hydrant branch, which can be closed whenever it is necessary to repair the hydrant.

A saving in the cost of specials can be made by taking the hydrants off the smaller side lines near the main, as shown in the sketch, and this will not increase the friction loss to any extent. The gate shutting off this branch line, in connection with others beyond, shuts off the hydrant without shutting off the pumping or supply main.

LOCATION OF THE PIPES IN THE STREETS.

There ought to be more uniformity in regard to the portion of the street in which the pipe is laid. The writer's practice has been to lay the pipes on the north or east side, and about one-third of the width of the street away from the street line.

There is apt to be more sun on those sides of the street in winter, and probably the frost goes to a less depth. This rule cannot always be followed, but as a general thing it is a good one. The center ought to be left for the sewer, if one has not already been built. The south or west side can be used for the gas pipe.

Sometimes the water pipes are laid from one side to another to avoid ledge or boulders. This is not good practice, and the man who follows, with another system of pipes will not be happy.

Mr. Diven in his excellent paper read at Louisville last year, has spoken of the necessity of complete records of the location of all pipes, gates, branches, etc. The writer has adopted a method which has given excellent satisfaction on several works. The sketches are made in heavy India ink lines on tracing cloth, within a rectangle seven and one-quarter inches by six inches, with a margin of one-half inch on the side for binding. The sheet of tracing cloth might be two feet by three feet, containing eighteen pages or rectangles.

Black India ink lines mark the boundaries of these rectangles, and surround the outside. One or more sketches can be put on one space, but plenty of room should be allowed to make everything, and especially the figures, plain and intelligible.

A blue print is then made, and is cut up by following the division and outside lines.

This makes all the pages exactly the same size. For a small sum a bookbinder will bind them in substantial covers.

The advantage of this method is, that after the tracings are made any number of blue prints can easily be taken, and if a book is lost the original is still left. A complete alphabetical index, also made on tracing cloth, from which to take blue prints, makes it very easy to find any desired gate or branch.

A number of these books can be made and one given to the Superintendent, one to each Water Commissioner and one to the Town or City Clerk to keep as a record.

With this paper is presented a sample blue print sheet of location sketches made last year for the town of Marblehead, also one of the books. These books were bound for twenty-five cents each.

As it may be of interest to some members present, whose works are in a town or city laid out in a rectangular manner, with wide streets, one of about eight similar sheets showing the streets in the old part of Marblehead, is herewith presented. The streets are in many places solid ledge, and not over thirty feet from house to house. The difficulties of laying pipe in such narrow, crooked, rocky streets can be imagined. About 6,000 cubic yards of rock excavation were removed in laying about eight miles of pipe last year, and about the same amount is expected in a similar extension the present season.

WEIGHT OF CAST IRON PIPE.

Much has been said and written on this subject, but there are two considerations which must be borne in mind in determining the required weight of thickness, and which make it difficult to depend much on theory. One is the fact that pipes must have a certain thickness to stand transportation, and the other is deterioration of pipes from corrosion or other causes. The latter is probably slight, but an accurate knowledge of it can only be obtained by many years experience.

Much useful information could be obtained by the careful testing of old pipes, which have been in the ground many years. The bursting pressure, weight and thickness should be obtained. The comparison of the weight and thickness with those the pipe possessed when laid would furnish interesting data. If the bursting weight of a similar pipe, from the original lot had been taken, this again would furnish interesting and useful knowledge.

For ordinary heads, not over 175 feet, the following weights of pipe will be found satisfactory:

4	inch,	20	pounds	per foot.
6	"	30	"	" "
8	"	45	"	" "
10	"	62	"	" "
12	"	80	"	" "

Taking into account the rough handling pipe is likely to receive in transportation, and the fact that it will certainly be no stronger, as successive years go by, the above weights are about right.

BELLS AND JOINT ROOM.

Bells should be three inches deep, for four and six inch, and three and one-half inches for eight, ten and twelve inch pipe. The joint room for the above sizes should be three-eighths of an inch.

CURVES.

Curves can easily be laid to a radius of 300 feet, with straight pipe. By occasionally cutting a pipe and using a sleeve, the writer has laid twelve-inch pipe on a curve of eighty feet radius. The pressure at the point is ninety pounds per square inch, and there have been no leaks, although the pipe has been laid nearly five years.

TEES OR YS.

Tees or right angle branches are better than Ys in many localities, even though the angle in the streets differ considerably from a right angle. By putting the Tee in at just the right place, an easy curve can be made of short bell pieces, which often accumulate, and the pipe brought onto the proper side of the street. If the branch is from the force main, and is between the pump and the reservoir, the resistance to the passage of the water will be the same, whether the water is coming from the pump or from the reservoir. The sketch shows this.

WATER AND SEWER PIPES NOT TO INTERFERE.

Especial attention ought to be given to the fact that if a sewerage system should be established in the future, man-holes will be necessary at the street intersections, and as it is necessary to make the sewers straight from man-hole to man-hole, the required space should be left for them, and the sewer pipe. This is especially true where there is much rock excavation.

SERVICE PIPES.

Lead is no doubt the most durable, but there is a prejudice against it in some minds which makes the use of some good substitute desirable. Plain wrought iron pipe lined with pure cement, makes a service pipe which is very durable, does not fill up with rust, is capable of being bent to some extent, and is cheap. The cost of lining an inch pipe with cement, so as to make it three-fourths inch in diameter, need not be over one cent per foot. The Tees and couplings can be lined with lead or a mixture of lead and tin.

Samples which have been in the ground ten years are smooth and clean inside as when put in, whereas tarred, enameled, or even galvanized iron pipe in many cases would be completely filled with rust.

GATE BOXES.

Various forms of iron boxes are in use which give excellent satisfaction. In country streets they should be set about an inch higher than the street surface, and have a ring of stone paving around them twelve or fifteen inches wide.

THE MISSISSIPPI RIVER.

BY WILLIAM MOLIS.

In this paper I will endeavor to give some thoughts to the upper Mississippi River, the depth, current, flows, the washing of sediment, with some regard to filteration of the same.

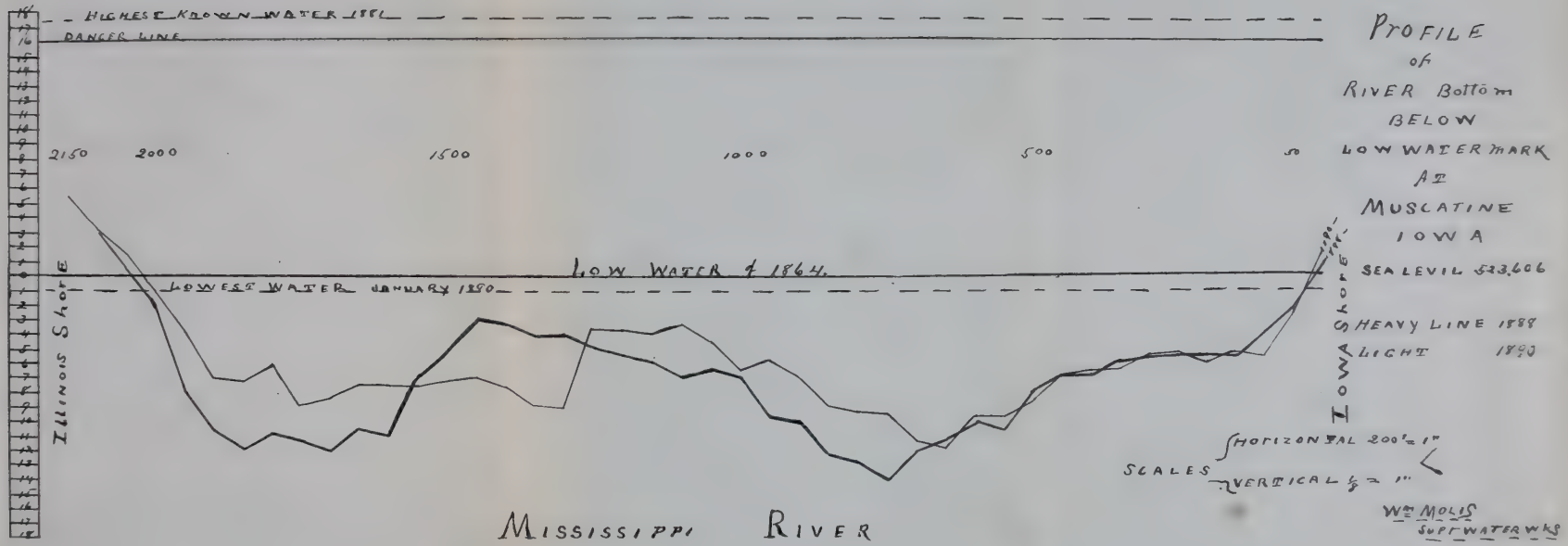
The waters of the upper Mississippi comes mostly from the drainage of vast agricultural lands lying along its banks, with some small streams flowing therein; but the greater quantities come in the spring of the year from the snow melting in the northern parts. Having kept a record of the stage of water in the river at my station for the last ten years, both for the signal service and my own company, I can give you some facts as to the rise and fall of the same. Commencing in 1878, to the present date, we have an average of 5 feet and 10 inches above low water mark. The highest average for any one year was in 1881, it being 9 feet above low water mark. The lowest average was in 1889, being 2 feet and 4 inches below low water mark, and the highest known water in this period was 17 feet 5¾ inches; the lowest for the same time was in January, 1890, being one foot below bench mark. Before I go further I will explain the bench, or low water mark, it being established for the upper Mississippi River in 1864 by the signal service, for the then known lowest water. The January record was the lowest known water on the upper Mississippi. You may have seen the reports going the rounds of the press, stating that the river had almost gone dry, and that the many waterworks receiving their supply therefrom were in danger of losing, or being out of a supply of water for their respective cities. No doubt there were

some who experienced some trouble in that respect, but as to the river going dry, I would say it is a mistake. Having made soundings of the river at my station in the year 1888, and again in 1890, to ascertain the depth of same, I am prepared to tell you some facts not generally known. You will see by the profile here shown the various depths of the river. These soundings were taken every 50 feet on the ice. The width of river is 2,250 feet, the deepest part being 14 feet and the shallowest part some 3 feet below low water mark, and the average being 7½ feet. What I wish to call your attention to is the changes that have taken place in two years, shows the channel changing and the sand and mud washing from one place to another. You will almost always find the lighter particles and the mud deposited on the shores, washed there by the winds and waves; the gravel and sand you will find in the channel of the river, or, in other words, the sediment and waters keep constantly moving about from one place to another, carrying the sand and clay with it. Now as to the flow and currents of these waters. It is estimated that the flow, or discharge, for low water is 19,000 cubic feet per second, with a velocity of 1.536 feet per second, and the same for high water is a discharge of 251,384 cubic feet per second, with a velocity of 4.3456 feet. The amount of sediment, estimated by the American Public Health Association, carried into the Gulf of Mexico annually, is some 400,000,000 of tons, and it contains 40 grains per gallon of sediment.

By the courtesy of Major MacKenzie, Corps of U. S. Engineers, to whom I am indebted for the above estimates, I am enabled to give some results to ascertain the amount of sediment held in suspension by the waters of the Mississippi River at Burlington, Ia., in 1879, during the months of April, May and June. The water was taken from the river in a sediment measure, constructed especially for this purpose. The measure consists of a hollow, steel cylinder, closed at the top and bottom by fixed brass plugs, the top plug being provided with an opening closed by a conical valve, which is held firmly to its seat by a spiral spring, and by means of a cord attached is opened as desired. By means or brass clamps the measure may be attached to a pole and lowered to any depth desired. The water was taken at depths of 1 and 12 feet below the surface, at a point where the water was 13 feet deep. The amount of water obtained at each observation was equal to the capacity of the measure, which was found to be 2,375 grains. The water was emptied into glass jars and allowed to settle. After having settled a given time it was syphoned off, except about half an inch in the bottom of each jar. The syphoned water was placed in a new jar for further examination, and the residual water, after being thoroughly shaken, was filtered through a pair of filter papers, which had previously been carefully ballanced so as to be of exactly the same weight. After the filteration the papers were dried, and the difference in weight was adopted as the weight of the sediment. The above process was repeated until no deposit was preceptible. It was found that sand and the coarser detritus would settle in about 15 minutes, all except clay would settle in 24 hours and clay in about 100 hours, although in some cases the water would retain a milky appearance for a few weeks. The proportion of sediment to water is so small that a long series of observations would be necessary to give definite data. I might add that some very extensive experiments were made at St. Louis, Mo., by James H. Seddon, Esq., C. E. on the water supply of that city on the settlement of sediment in their waters, which I presume you

have all read with much interest. Now as to the quality of water, it does seem to any reasonable mind that in so large a river the sewerage and objectionable matter it contained would be destroyed in the revolving currents of the waters and be ground out of existence. I believe all filtering plants of to-day are on the principle of gravating the waters through the sand of their respective plants. We have, situated on our stream, cities varying from 500 to 50,000 inhabitants, and from 20 to 60 miles apart. The water, on analysis, shows it to be free from all objectionable matter, save clay in suspension, and about 10 degrees of hardness. The rain fall for the last 10 years averaged 37.985 inches yearly for this section of country. Now take this large volume of water, estimated above, or, to better understand the vast amount of water contained in the high water discharge, we will suppose a lake twenty miles long and five miles wide. The river, flowing as above, would raise its surface at the rate of $7\frac{8}{10}$ feet per day. In one week it would discharge about one cubic mile of water, enough to fill the bed of the Mississippi, averaging its width 2,737 feet wide, with an average of 22 feet deep, a distance of 450 miles. This is about thirteen times the low water discharge. Now, with the scouring process going on, it does seem that it would take a vast quantity of sewerage to affect its purity, and that any deterious matters entering therein would be purified to a certain extent, if not wholly, of any objectionable matters it contained. But, on this question there seems to be a great difference of opinion. In experiments in England some years back made on this subject while one party makes the assertion, that all sewerage matter is destroyed in a few miles' flow in a large volume of water, and the other, I believe the river pollution commission says such a thing is impossible. The fact has not yet been established to come to a correct conclusion. The one objection to our river waters is the spring freshets coming down in torrents, carrying a large amount of mud and sediment at these times, but to overcome these changes, if a settling or storage reservoir could be had it would help most water supplys out of the difficulty during these times, and the water supply made good. Another important point I wish to mention would be to have overflows on or near the top of reservoir to take off all such lighter matter, which will always rise to the top of same. We clean out our reservoir once a year, and find mud from one to two inches deep; the capacity of same is about 2,000,000 gallons, and in addition to this we flush our mains about every two months, using the full opening of pipe, and in a 10-inch main, about $1\frac{1}{4}$ miles long, it takes 15 minutes to do the work under a head of 190 feet, so you can see how much sediment accumulates in this pipe. That the river water is liable to be contaminated there is no doubt, but with such volumes of water pouring down its bed the objectionable matter will have little effect on the water supply. Almost any food or drink needs watching very closely. The water supply may not be pure, but you will see in any of our produce stores, almost anywhere you may go, the various brands of eatables exposed to the store and street sweepings day after day, but naught is said, although you look with suspicion on the water supply. Whether artisan well waters are more healthy than our river waters remains yet to be determined. I believe there are no data on record to show the effect of either supply on the health of the inhabitants using one or the other. I have now written more than I intended to, but there could be volumes talked on this subject without an end.

Changes in River Bottom.



PROFILE
of
RIVER Bottom
BELOW
LOW WATER MARK
AT
MUSCATINE
IOWA

SEA LEVEL 523.606

HEAVY LINE 1888
LIGHT 1890

SCALES { HORIZONTAL 200' = 1"
VERTICAL ½ = 1"

Wm MOLIS
SUPT WATER WKS

ON THE WATER POWER OF ROCK RIVER, MICHIGAN.

BY SAMUEL M'ELROY, C. E.

Under a deed of 1860, subsequently acquired by the city of Three Rivers, Michigan, it owns the right to one-eighth of Rock river, at its entrance into St. Joseph's river, and about 1882, erected a pump-house and flume, with two turbine wheels, one a "forty-eight inch Jonval," the other a "thirty inch Victor," drawing their supply, for domestic use, from a gang well system below the dam, and for fire use, from the dam.

Under a suit for damages brought against the city, by the proprietor of the flour mill on the same pond and dam, various questions were raised, involving a careful measurement of the supply and use of the water, in ordinary and low seasons, from which, as made in behalf of the city, the following notes are collected:

The flow of the stream, as to its usual power, was determined by a measurement of its drainage basin and rain-fall; by ordinary water mark checks at the dam, transferred to its overflow; and by pond, flume, and weir measurements on the river and tail race; also, by analysis of the wheel supply required to run the mill and pumps.

DRAINAGE BASIN.

Rock river is a prominent affluent of St. Joseph's river, which it enters just below the dam. It drains in part Cass, St. Joseph's, Kalamazoo, and Van Buren counties; its main westerly branch being about twenty miles long. With a rapid fall at certain points, it furnishes valuable mill power, while other valleys are broad and flat; and it is specially remarkable for the numerous lakes, ponds, and swamps on its upper basins.

There are not less than thirty-eight more or less prominent lakes, and eight large swamps in its basin. Some of the lakes, as "Howardsville," are two and a half miles long; "Pleasant," "Coffs," and "Bankson's," one and a half mile; "Miller" one mile; while the feeding swamps are also large; one of them about three and a half miles in length by at least one half average width. This reservoir system produces a very beneficent effect on the regular flow of the stream.

At the time my measurements were made the basin was suffering from its second dry year. There was no rain-fall at Three Rivers, from July 3d to September 11th, 1888.

After carefully mapping the basin, by collecting authentic town maps, and personal study of the divides and stream flow, the entire area was computed at 137.28 square miles.

RAINFALL.

Examination of various reports showed, between 1875 and 1888, a mean fall on the southern section of Michigan, of 36.33 inches; (crop report, Secretary of State). Reports for Kalamazoo, showed 38.03 inches; a Parville return, Sept. 1, 1887, to 1888, 36.41 inches.

Assuming 60 per cent. as a safe standard of river discharge, on 36.33 inches, the flow of Rock river dam would average 13,227 cubic feet per minute. A wier computation of the dam, based on water marks on the shed posts and stones near the overflow, gave, with the mill waste and city use, 13,759 cubic feet.

From a careful estimate of the mill pond prism, a large sheet of about eighty-five acres, as refilled at night, in September, added to the

mill waste and city use, the flow of the stream was made 7102.75 cubic feet per minute, or 53.57 per cent. of the mean annual flow and 32.12 per cent. of the mean rainfall.

The theory is fashionable now, that there is a gradual diminution of stream flow, while statistics show no diminution of rainfall, for a given number of years. If the rainfall hold, the only changes in stream flow must come from changes in the retentive power of the basin. Forest denudation tends to increase flood supply, and diminish ordinary flow, but agricultural improvement, by increase of absorbing areas, tends to balance the effect in the warmest months. Until our streams are subjected to careful measurements of flood, ordinary and minimum flow theories about them are speculative. The common theory that annual evaporation exceeds rain supply, is wrong, on inspection, and will be, as long as streams actually flow into the sea.

The ordinary flow of a stream depends, for its uniformity, chiefly on the conditions of its storm reserve.

On the southern slope of Long Island, which is an enormous filter bed of sand and gravel, the streams which crop out, near tide level, are remarkably uniform in flow. Freshets are rare, and of short duration, and rarely double the mean discharge; the minimum flow is also a high percentage of the rain supply.

Rock river illustrates the conservative effect of large reservoir area on the stream, in its supply of about one-third flow of the mean rainfall, at the end of a long drought.

Other basins, as reported, are usually much more irregular. By one report, (Beardsley, manual, page 200,) the Mississippi gives in cubic feet per minute six millions minimum, thirty-three mean, sixty maximum; the Rhine, one million minimum, 2.34 mean, 10.62 maximum; the Garonne, 127,140 cubic feet minimun, 1.44 mill. mean, 32.25 maximum; the Nile, 0.72 minimum, 10 mean, 21.72 maximum; the Housatonic, (Loomis, Mahopac case, 1878,) 15.83 minimum, 29.75 mean, 53.23 maximum; the Croton, (ag. reports,) in very dry years appears to run down to 2935 cubic feet per minute on 338 square miles basin, with a mean of about 39,720, and an occasional maximum of 612,000 reported.

A mill power analysis of the Kennebec, made Dec. 1888, showed that on the Augusta dam, for about twenty to twenty-five days, a very low run was about 36 cubic feet per minute per square mile, and for about ninety days 56.5 cubic feet; applied to Rock river they would show an extreme minimum of 4942 cubic feet, and a low summer run of 7756 per minute, nearly the minimum determined. The Kenebec is exceptional for its natural reservoir system. Above Caratunk Falls a basin of 2850 square miles, has in lakes about 229.6, available for about 37.800 millions cubic feet. The reserve system of the Merrimac at Lowell of 4453 square miles basin, has 6,690 cubic feet; and the minimum sale of power amounts to about 48.45 cubic feet per square mile, or 215,760 cubic feet per minute.

CITY USE.

The mill on the east side of the dam discharges through a tail race into St. Joseph's river, while the city pump-house was located below the dam on the west side, discharging by a short tail race into Rock river. Some three or four hundred feet below, a wier was built in 1886, across the river by the mill proprietor, to be used for measurements of the river flow and city use, while the tail race of the mill was measured by channel floats.

For its ordinary water supply one wheel and pump was used by the city in September, 1888, with about 830 cubic feet minimum supply from the dam, on 10.25 head. The pump duty, under usual speed and pressure, was 8.94 horse power. The water used, under the given head would give, with a wheel of seventy per cent. duty, 11.25 h. p., or 20.62 per cent loss. The flume and river waste, measured on the weir was about 88.5 cubic feet per minute.

MILL USE.

The mill was then running on part time, drawing the pond down daily to a minimum level, for night refill; average running time 9 hours 17 minutes per day. Under a full head of about 12 feet, the race flow was 13,976 cubic feet per minute, or 220.86 h. p. (at 70 per cent. wheel duty). Under a head of 13.97 feet, the ordinary waste was 986 cubic

feet per minute, or 17.36 h. p. The actual head available, but not used from tail race defects, was about 14.6 feet.

The present power consists of two "forty-eight inch Leffel" wheels, twelve inch buckets, and one "special fifty-two inch," fourteen inch buckets, with one "American forty-eight inch," twelve inch buckets. These were put in in 1887, and have, under 12.5 feet head, a total horse power of 292.44, requiring a supply of 14,086 cubic feet per minute, assuming high tabular duty, or at 70 per cent. duty, 17,692 cubic feet, a quantity far beyond the capacity of the dam for twenty-four hours use.

The mill is fitted for the "roller" system introduced here about 1880. At a close estimate of 4-10 h. p. (shaft) per barrel flour, the mill rated at 500 barrels per day full capacity, with 70 per cent. wheels would use ($500 \times 0.457 =$) 228.5 h. p. as used and rated, with the "American" on custom work, about one hour per day, (as testified), the three wheels on flour production, have 237.8 h. p. and require (by table) 11,323 cubic feet minute, and at 70 per cent. 14,987 cubic feet.

MILL STRUCTURE.

The mill was built about 1832 as a grist mill, driven by a beast wheel. About 1860, center vent scroll wheels were put in to drive four runs of four and a half feet French buhr stones; head about ten feet, capacity 80 to 100 barrels per day.

UPPER MILLS.

At Howardsville, on the west branch, about 9⅝ miles from the dam, there are a large flour and grist mill and pond; at Flowerfield on the main stream, at about the same distance, there are another mill and pond. By boat examination on the main stream, for some distance, the mean river speed was found about 1.37 miles per hour. At this rate it would take seven hours after the gates were opened at each place, to reach the lower pond; but as the measurement of the pond was made on the quantity refilled for 883 minutes of night and day, it includes pond as well as stream flow, at a level below the lip of the dam, without complication as to supplies during actual mill use of 557 minutes.

LEGAL QUESTIONS.

The city acquired title under a deed of Nov. 10, 1860, which conveyed the "undivided one-eighth of the land flowed by said pond," and "the undivided one-eighth part of the Rock river water power," guarded in two ways: first, the right to use beyond any deficit from "said pond" water to "fill an opening fifteen inches square, under eight feet head," reserving priority to the mill of "a sufficient amount of water, properly used, to drive four runs of French buhr mill stone, with all necessary machinery," and giving the city "a proper use of the river below the bridge," with the usual provision against "unnecessary waste of water."

SUIT.

The claim for damages by the mill proprietor is, that he is entitled to water for four runs of stone, before the city can draw it, and by working its wheel the City used a large amount of the reserved water power, obliged the mill at various times to stop between July and Dec., 1887, causing loss and damage to the amount of $5,000.

The testimony (Caldwell Foreman, p. 33) claims an unlawful use of

1314 cubic feet per minute for one hundred days at thirty-three cents profit on sixty-two barrels a day, given at $2,170. The jury being in a hurry to catch Saturday night last trains, deliberated over the case about one half hour, and gave a verdict for plaintiff of $1,084. Carefully splitting the claim in two.

On appeal the Supreme Court in December, 1889, set this verdict aside, holding the absolute right of the city to use one eighth of this power.

CONDITIONS PROVED.

The minimum capacity of the stream after about three months continuous drought is found to be 7102.75 cubic feet per minute, of which one eighth is 885.34 cubic feet, or about the actual city use per day time supply; much less consequently at night.

The mean flow of the stream is about 13,237 cubic feet per minute estimated by rainfall, and by natural water marks, 13,759.

The power required in 1860 to run four runs of stone, and machinery, as to shaft and wheel power, may be thus analyzed:

Although instances occur of four and one half stones grinding sixteen to twenty-five bushels of wheat per hour, proper milling experience limits the work for first-class flour, to not more than ten bushels. In this case while the plaintiff's witnesses naturally increase the rate to "fifteen to sixteen bushels" (page fifty-three), or "fifteen to eighteen bushels" (page eighty-two), other competent men say "to do good work, nine bushels, not over ten," (page eighty), while an expert of great experience, like Wm. M. Mills of Dayton, O., says "about nine bushels, this is equivalent to about two barrels of flour per hour.

An elaborate examination of mill experience, made for the Niagara cases in 1883-4, showed 12 h. p., per bushel, for grinding and other processes of flour manufacture, or 12 h. p., per run on the shaft. Mr. Mills puts it 13.33 h. p., in such a case as this.

The duty of the "scroll" wheels here used was carefully studied. American engineers are trained by necessity to secure the highest result from the least expenditure, and it is a credible but not a singular fact, that what is now the most successful type of turbine , or a horizontal inward flow, downward central discharge wheel, with expanding buckets, was introduced in 1804 by Benjamin Tyler of Cleremont, New Hampshire, as the "Wry Fly," with scroll curb and scroll buckets, and for many years this was the common wheel in use, rude in material and workmanship, it yet developed the highest principal of action, and is on record with a duty of sixty-seven to seventy-four per cent. —Hydraulics pages 80 to 131.

Assuming sixty per cent duty, the total water power required for one run is about 20 h. p., or for four runs 80 h. p., on ten foot working head, this would use (88.232 + 80)7059 cubic feet per min. But four runs produce 192 bbls per day, or twice the production of this mill of 1860, as testified. With one run usually under dress, and one for custom work, the actual water use given was 3676 cubic feet per minute under eight feet working head, for 100 barrels per day.

The actual mill water use of Sept. 1888, was 13,971 cubic feet, equivalent to 225.86 h. p., at seventy per cent wheel duty, and of this the constant waste was about 986 cubic feet per minute, or considerable more than the actual city use.

The flow of an aperture of fifteen inches, under eight feet head is 2196.62 cubic feet per minute, if, under the special language of the deed the full opening is assumed. If assumed as a well made flume leading into a wheel with a close draft tube, the amount is about 1956 cubic feet, or more than twice the low water reservation conveyed, equivalent, on sixty per cent duty of wheels on eight foot head, to 17.64 h. p.

The minimum flow of the river at 7102.75 cubic feet on ten feet fall, for sixty per cent wheel, is 80.5 h. p., for continuous run, one eighth of which would cover the actual city use; but nothing in the deed establishes the right to continuous daily mill run in low seasons; the conveyance of pondage, establishes the use if made operative; and the rule established by custom precludes any interpretation of continuous use.

It was quite evident therefore to the city experts in the case, that the claim for damages did not rest with the mill proprietor, and that a Supreme Court is safer than a tired jury, where the law and evidence have been carefully presented.

PERSONAL OF COURT.

Hon. Erastus Peck, Judge; Plaintiff, Lewis Emory; Counsel, Pealer Bros, and Dallas Bondeman; experts Joshua Kerns, Lima, O; James Barker, Appletot, Wis; Defendents Counsel, W. L. Howell, N. H. Barnard, B. E. Andrews; experts, Wm. M. Mills, Dayton, O; Samuel McElroy, Brooklyn, N. Y.

LIST OF MEMBERS.

HONORARY.

Y. Nakajima, Imperial University ..... Tokio Japan

ACTIVE.

Abbott, E. L., Hydraulic Eng. ..... 12 Temple Court, N. Y
Alexander, W. A., Sup't Penna. Water Co ..... Wilkinsburg, Pa
Allen, Chas. P., Sup't Water Works ..... Denver, Col
Alsterlund, J. F., Ch'f Engr. Water Works ..... Moline, Ill
Andrew, Jas. H., Sup't Water Works ..... Central Falls, R. I
Andrews, M. L., Sup't Water Co ..... Arkansas City, Ark
Archer, James, Water Co ..... Denver, Col
Armstrong, Edw., Su'pt Water Works ..... Alegheny City, Pa
Artingstall, Samuel G., Civil Engineer ..... Chicago, Ill
Ayres, H. W., C. E. Water Works ..... Hartford, Conn
Ayres, Sylvanus, jr., Manager Water Works ..... Bound Brook, N. J
Babcock, S. E., C. E. Water Works ..... Little Falls, N. Y
Bailey, D. A. B., Sup't Water Works ..... Findlay, O
Baird, G., Physician ..... Wheeling, W. Va
Ball, Phinehas, Hydraulic Engineer ..... Worcester, Mass
Barnard, W. W., Executive Com ..... Rochester, N. Y
Barnet, Jno., Sup't Water Works ..... LaFayette, Ind
Barney, W. H., Sup't Water Works ..... Milford, Mass
Barrows, F. C., Chairman Water Committee ..... Minneapolis, Minn
Beach, G. E., Hydraulic Engineer ..... Minneapolis, Minn
Bement, R. C. B., Ch'f Engr. Duluth Water Co ..... St. Paul, Minn
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Bergstrom, Andrew, Mechanical Engr. Water Works ..... Minneapolis, Minn
Birkinbine, Harry, C. E. Water Works ..... Council Bluffs, Ia
Bixby, Walter A., Sup't Water Works ..... Galena, Ill
Bond, Joseph A., Ch'f Engr. Water Dep't ..... Wilmington, Del
Bowen, Wm., Mechanical Engineer ..... Davenport, Ia
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Brooks, Isaac W., Pres't Water Co ..... Torrington, Conn
Brower, Edw. A., M. E. Waterworks ..... Catskill, N. Y
Brown, A. L., M. E. Water Works ..... Salem, Oregon
Brown, Calvin S., with Hersey Meter Co ..... Boston, Mass
Brown, E. H ..... Grass Valley, Cal
Brown, J. Henry, Sup't Mystic Div. Water Dep't ..... Boston, Mass
Brown, Milton A., Sup't Water Co ..... Perth Amboy, N. J
Brush, Chas. B., C. E. & Sup't Water Works ..... Hoboken, N. J
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Bull, William B., Sup't Water Works ..... Quincey, Ill
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Chandler, Geo. H., Engineer Water Works ..... Kalamazoo, Mich
Chase John C., C. E. & Sup't Water Works ..... Wilmington, N. C
Chipman, Willis, Ch'f Engr. Water Co. ..... Brockville, Ont
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Ellis, Geo. A., Civil Engineer ..... Boston, Mass
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Gray, L. E., Sup't Water Works ..... Albany, Oregon

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Harlow, Geo. R., Constructing Engineer ..... Pittsburgh, Pa
Harrington, W.K., Sup't Water Works ..... Green Bay, Wis
Harris, S. W., M. E. Water Works ..... Racine, Wis
Harris, W. T., Sec'y & Treas. Water Co ..... Jackson, Tenn
Harrison, H. H., Sup't Water Works ..... Stillwater, Minn
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Heermans, H. C., Sup't Water Works Co ..... Corning, N. Y
Henion, J. W ..... Minneapolis, Minn
Henderson, Wilson, Sup't Water Works ..... Peterborough, Ont
Hering, Rudolph ..... New York, N. Y
Hermany, Chas., Chief Engineer Water Works ..... Louisville, Ky
Hill, John W., Mech. Eng ..... Cincinnati, Ohio
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Holden, H. G., Sup't Water Works ..... Nashua, N. H
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Holly, Frank W., Mechanical Engineer ..... Lockport, N. Y
Holman, M. L., Water Commissioner ..... St. Louis, Mo
Holme, Richard, Sec'y and Sup't Water Co ..... Denver, Col
Holme, Richard, jr., Cashier Water Co ..... Denver, Col
Hood, Charles, Superintendent Water Works ..... Burlington, Ia
Hooper, Thomas N., Chief Engineer Water Works ..... Davenport, Ia
Hornung, Geo., Civil Engineer ..... Newport, Ky
Howland, A. H., Constructing Engineer ..... Boston, Mass
Jackson, F. W., Sup't Water Works ..... Oak Park, Ills
Johnson, J. B., Prof. Civil Eng. Washington Univ ..... St. Louis, Mo
Jones, A. J ..... New Brunswick, N. J
Jones, B. F., Sup't Water Co ..... Kansas City, Mo
Jones, C. A., Asst Sup't Water Co ..... Kansas City, Mo
Jones, J. I ..... Kansas City, Mo
Jones, R. M., Manager Water Works ..... Wyandotte, Kan
Joy, Moses, jr., President Water Co ..... Petersburg, Va
Judson, Charles A., Sup't Water Works ..... Sandusky, Ohio
Keating, E. H., City Engineer ..... Halifax, Nova Scotia
Keeler, H. E., Director Charleston, Ill., Water Co ..... Chicago, Ill
Kelley, John C., Director Water Works ..... Brooklyn, N. Y
Kent, A. F., Pres't and Sup't Water Co ..... Jamestown, N. Y
Koch, H. G., Sup't Water Works ..... Aspen, Colo
Knickerbocker, John, Mechanical Engineer ..... Troy, N. Y
Kuhn, W. S., Contracting Engineer ..... McKeesport, Pa
Kuhnen, N., Pres't Water Co ..... Davenport, Ia
Laing, W. H., Sup't Water Works ..... Racine, Wis
Lakin, John T., Sup't Water Works ..... Rockford, Ill
LeConte, L. J., Civil and Consulting Engineer ..... Oakland, Cal
Leeds, Albert R., Consulting Chemist ..... Hoboken, N. J
Linneen, P. H., Mechanical Engineer ..... Chicago, Ill
Loweth, Chas. F., Civil Engineer ..... St. Paul, Minn

Ludlow, Wm., C. E.....Detroit, Mich
Lyman, I. L., Comm'r and Sup't Water Works.....Lincoln, Neb
McAlpine, A. H., Chief Engineer Water Works.....Columbus, Ohio
McCallum, A., Mechanical Engineer.....Philadelphia, Pa
McConnell, B. D., Sup't Water Works.....Montreal, Can
McConnell, W. C., Pres't Water Co.....Shamokin, Pa
McElroy, Samuel, Civil Engineer.....Brooklyn, N. Y
McWilliams, James, Sup't Water Co.....Seattle, Wash
Manning, Chas. F., Sup't Water Works.....Hagerstown, Md
Marret, P. J., Ass't Engineer Water Co.....Louisville, Ky
Martin, H. P., Sup't Water Works.....Owensboro, Ky
Martin, John, Engineer Water Works.....St. Johns, Newfoundland
Martin, Robert K., Chief Engineer Water Dep't.....Baltimore, Md
Martine, A. H., Eng. and Sup't Water Works.....Knoxville, Tenn
Maxwell, Jas. R., Consulting Engineer.....Cincinnati, Ohio
Mead, D. W., Constructing Engineer.....Rockford, Ills
Messinger, W. H., Chief Engineer Water Co.....Lynn, Mass
Mills, Wm. B., President Water Co.....Denver, Col
Milne, Peter, Jr., Consulting Engineer.....New York, N. Y
Milner, W. J., Secretary and Supt. Water Works.....Birmingham, Ala
Mitchell, Wm., Supt. Water Works.....Ottawa, Kas
Mitchell, W. C., Supt. Water Works.....Janesville, Wis
Molis, Wm., Supt. Water Works.....Muscatine, Ia
Monjeau, C., Hydraulic Engineer.....Cincinnati, Ohio
Moody, Frank F., Registrar Water Dept.....Minneapolis, Minn
Moore, A. G., Engineer and Supt. Water Works.....Cincinnati, Ohio
Moorhead T. S., Civil and Hydraulic Engineer.....Arcadia, Fla
Morley, Philip, Supt. Water Co.....East Liverpool, Ohio
Morse, C. W., Supt. Water Works.....Haverhill, Mass
Morton, B. R., Civil Engineer and Supt. Water Works.....Newport, Ky
Murdock, Gilbert, Civil Engineer and Supt. Water Works.....St. Johns, N B
Neagle, P. J., Inspector Water Works.....Elmira, N. Y
Nettleton, C. H., Agent Water Co.....Birmingham, Conn
Neville, Thos. J., Water Registrar.....Rochester, N. Y
Newton, H. M., Secretary and Supt. Water Works.....East Saginaw, Mich
Nichols, C. M., Supt. Water Works.....Madison, Wis
Northway, Wm. R., City Engineer.....Chicago, Ills
Ogden, John L., Chief Engineer Water Dept.....Philadelphia, Pa
Owen, James, Supt. Water Works.....Montclair, N. J
Page, J. B., Supt. Water Works.....Lynchburg, Va
Parkin, R. R., Supt. Water Works.....Elgin, Ills
Parrott, H. C., Mechanical Engineer.....Lockport, N. Y
Partridge, N. A., Treas. Rogers Park Water Co.....Chicago, Ills
Pearsons, G. W., Civil Engineer.....Kansas City, Mo
Pearsons, R. C., Mechanical Engineer.....Kansas City, Mo
Perkins, P. B., Contracting Engineer.....Springfield, Mo
Phipps, E. H., Supt. Water Works.....West Haven, Conn
Pierson, Geo. H., Consulting Engineer.....New York, N. Y
Pitney, H. C., President Aqueduct Co.....Morristown, N. J
Polhamius, J. A., President Water Co.....Texarkana, Texas
Pond, F. H., Mechanical Engineer.....St. Louis, Mo
Potts, Isaac B., Mechanical Engineer.....Columbus, Ohio
Prentice, Allen T., Mechanical Engineer.....Chicago, Ills

Priddy, Chas. N., Secretary and Supt. Water Works ..... Leadville, Col
Quigley, J. R., President Water Co ..... Sedalia, Mo
Race, R. T., President Fredona, Ks., Water Co ..... Irving Park, Ills
Raeder, F. Wm., Consulting Engineer ..... St. Louis, Mo
Randall, J. M., Supt. Water Works ..... East Orange, N. J
Raymond, H. S., Secretary Galena Water Co ..... Chicago, Ill
Reyer, Geo., Chief Engineer Water Dept ..... Nashville, Tenn
Richards, W. G., Supt. Water Works ..... Atlanta, Ga
Rider, Joseph B., Hydraulic Engineer ..... S. Norwalk, Conn
Rider, W. B., Hydraulic Engineer ..... S. Norwalk, Conn
Rienecke, Wm., Secretary Water Co ..... Louisville, Ky
Robertson, Geo. H., Supt. Water Works ..... Yarmouth, N. S
Root, W. J., Mechanical Engineer ..... New York, N. Y
Ruger, Edward, Chief Engineer Water Co ..... Omaha, Neb
Rumsey, Israel P., Director Carlinville Water Works ..... Chicago, Ill
Russell, S. Bent., Asst. Engineer Water Dept ..... St. Louis, Mo
Ryle, Wm., Supt. Water Co ..... Paterson, N. J
Safford, J. P., with Engineering News ..... Chicago, Ill
Saunders, R. L., Civil Engineer ..... Jackson, Miss
Sawyer, J. T., President Water Co ..... Waverly, N. Y
Schaefer, August, Supt. Water Works ..... Maysville, Ky
Schefold, Frank, Supt. Water Works ..... New Albany, Ind
Schrop, Ira S., Supt. Water Works ..... South Bend, Ind
Sevier, S. Q., President Water Works Co ..... Camden, Ark
Shepard, Edwin, Manager Water Co ..... Seattle, Wash
Sheppard, F. W., "Fire and Water," ..... New York, N. Y
Schon, Carl, Civil Engineer ..... Toledo, Ohio
Searls, W. H., Civil and Consulting Engineer ..... Cleveland, Ohio
Sherman, W. B., Mechanical Engineer ..... Providence, R. I
Sickles, F. E., Chief Engineer Water Works ..... Kansas City, Mo
Smith, Anthony P., Supervisor Water Works ..... Newark, N. J
Smith, Erastus G., Consulting Chemist ..... Beloit, Wis
Snow, Eug., Jr., Constructing Engineer ..... Brooklyn, N. Y
Spaulding, Z. S., Supt. Water Works ..... Fort Payne, Ala
Sprague, W. W., ... Town of Lake, Ill
Stephens, Benj. F., Constructing Engineer ..... Flatbush, N. Y
Stevens, Andrew W., Constructing Engineer ..... Logansport, Ind
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Straw, Lafe W., Supt. Water Works ..... Danville, Ill
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Swain, Geo. F., Prof. Civil Engineering Mass. Ins. Tech. ..... Boston, Mass
Taylor, John W., Supt. Water Works ..... Newcastle, Pa
Taylor, L. A., Constructing Engineer ..... Boston, Mass
Tilden, Jas. A., Mechanical Engineer ..... Boston, Mass
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Tomlinson, Samuel, Dep. Ex. Engineer Water Works ..... Bombay, India
Tracy, Thos. H., Supt. Water Works ..... London, Ont
Troy, John W., Supt. Water Works ..... Pierre, Dak
Tubbs, J. Nelson, Chief Engineer Water Works ..... Rochester, N. Y
Turner, John H., Civil Engineer ..... Mobile, Ala
Utter, Geo. H., President Water Co ..... Silver City, N. M
Wadsworth, A. R., Supt. Water Works ..... Farmington, Conn
Walker, J. S., Chief Engineer Water Works ..... Birmingham, Ala

Watson, Walter, Civil Engineer..... Pittsfield, Mass
Watts, W. H., Supt. Water Works..... El Paso, Texas
Watts, Sylvester, Contracting Engineer..... St. Louis, Mo
Weller, John, Inspector Water Works..... East Saginaw, Mich
Wheeler, W. H., Supt. Water Works..... Beloit, Wis
Wilkerson, J. H., Supt. Water Works..... Bowling Green, Ky
Williams, L. H., Sec'y and Treas. Newcastle Water Co... Pittsburg, Pa
Wills, E. S., Supt. Water Co..... Atchison, Kan
Wiltsie, Myron, Engineer of Construction..... Rapid City, Dak
Wing, Fred, Construction Engineer..... Dallas, Texas
Wing, Geo. B., Cashier Water Works..... Kansas City, Mo
Wingfield, N., Chief Engineer Water Works..... Chattanooga, Tenn
Wirt, R. D., Supt. Water Works..... Independence, Mo
Woodruff, Timothy, Supt. Water Works..... Bridgeton, N. J
Wright, Millard F., Supt. Water Works..... Lowville, Mass
Yardley, Thos. W., Bureau of Inspection..... Chicago, Ill
Young, John, Civil Engineer..... Geneseo, N. Y

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Chapman Valve Manufacturing Co..... Indian Orchard, Mass
Chattanooga Foundry and Pipe Works..... Chattanooga, Tenn
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Clow, J. B. & Sons, Lake and Franklin sts..... Chicago, Ill
Columbus Water Works..... Columbus, Ohio
Deane Steam Pump Co..... Holyoke, Mass
Deutsch, Wm. M., Pres. Nat'l Water Purifying Co., 145 Broadway, New York
Eddy Valve Manufacturing Co..... Waterford, N. Y
Edson, Jarvis B., No. 91 Liberty St..... New York, N. Y
Equitable Water Meter Co., No. 36 India Wharf..... Boston, Mass
Fisher Governor Co., governors..... Marshalltown, Ia
Galvin Brass and Iron Works..... Detroit, Mich
Gordon Maxwell Co..... Hamilton, Ohio
Hall Electric Pump Co..... Plainfield, N. J
Hardwicke & Ware..... Buffalo, N. Y
Hays Manufacturing Co..... Erie, Pa
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Holly Manufacturing Co., Pumping Machinery..... Lockport, N. Y
Hyatt Pure Water Co., 16 Cortlandt St..... New York, N. Y
Illinois Malleable Iron Co..... Chicago, Ill
Jewell, O. H. & Sons, 26 Lake St..... Chicago, Ill
Jewell Pure Water Co., Lake and Franklin Sts..... Chicago, Ill
Jones & Laughlins, No. 27 West Lake St..... Chicago, Ill
Kellogg, E. H. & Co., No. 243 South St..... New York, N. Y

Lake Shore Foundry ..... Cleveland, Ohio
Long, Dennis & Co ..... Louisville, Ky
Ludlow Valve Manufacturing Co ..... Troy, N. J
McNeil, A. H ..... Burlington, N J
Marsh, W. H., Manager Tuerk Hydraulic Power Co ..... New York, N. Y
Michellon, J. P ..... Camden, N. J
Michigan Pipe Co ..... Bay City, Mich
Morgan, A. W., Manufacturing Co., 52 Niagara St ..... Buffalo, N. Y
Mott, J. L., Iron Works, 88 Beekman St ..... New York, N. Y
Mueller, H ..... Decatur, Ill
National Meter Co., 252 Broadway ..... New York, N Y
National Tube Works Co ..... McKeesport, Pa
Nelson, N. O., Manufacturing Co., 8th and Charles Sts ..... St. Louis, Mo
Norfolk Water Works ..... Norfolk, Va
Ohio Pipe Co ..... Columbus, Ohio
Oliphant, Wm ..... Jersey City, N. J
Paul, A. G., Fairbanks & Co., 311 Broadway ..... New York, N. Y
Payne, Walter S ..... Fostoria, Ohio
Reliance Oil and Grease Co ..... Cleveland, Ohio
Rensselaer Manufacturing Co ..... Troy, N. Y
Richards, H. DeC ..... Jersey City, N. J
Ripley & Bronson, 907–911 N. Main St ..... St. Louis, Mo
Robertson, R. A , Jr., Agent ..... Providence, R. I
Rouse & Hills Co ..... Cleveland, Ohio
Shickle, Harrison & Howard Iron Co ..... St. Louis, Mo
Spiral Welde Tube Co ..... East Orange, N. J
Strang, Samuel A., 30 Pine St ..... New York, N. Y
Union Water Meter Co ..... Worcester, Mass
Volker & Felthousen Manufacturing Co ..... Buffalo, N. Y
Water Waste Prevention Co., 12 Temple Court ..... New York, N. Y
Western Valve Co., 166 Lake St ..... Chicago, Ill
Wood, R. D. & Co., 400 Chestnut St ..... Philadelphia, Pa
Worthington, H. R., 86 Liberty St ..... New York, N. Y
Wortley, Ted & Co ..... Kansas City, Mo

Boiler Room Wall.

Flue

36"

12½"

16½"

Cross Section "C"

Cross Section "D"

36"

12½"

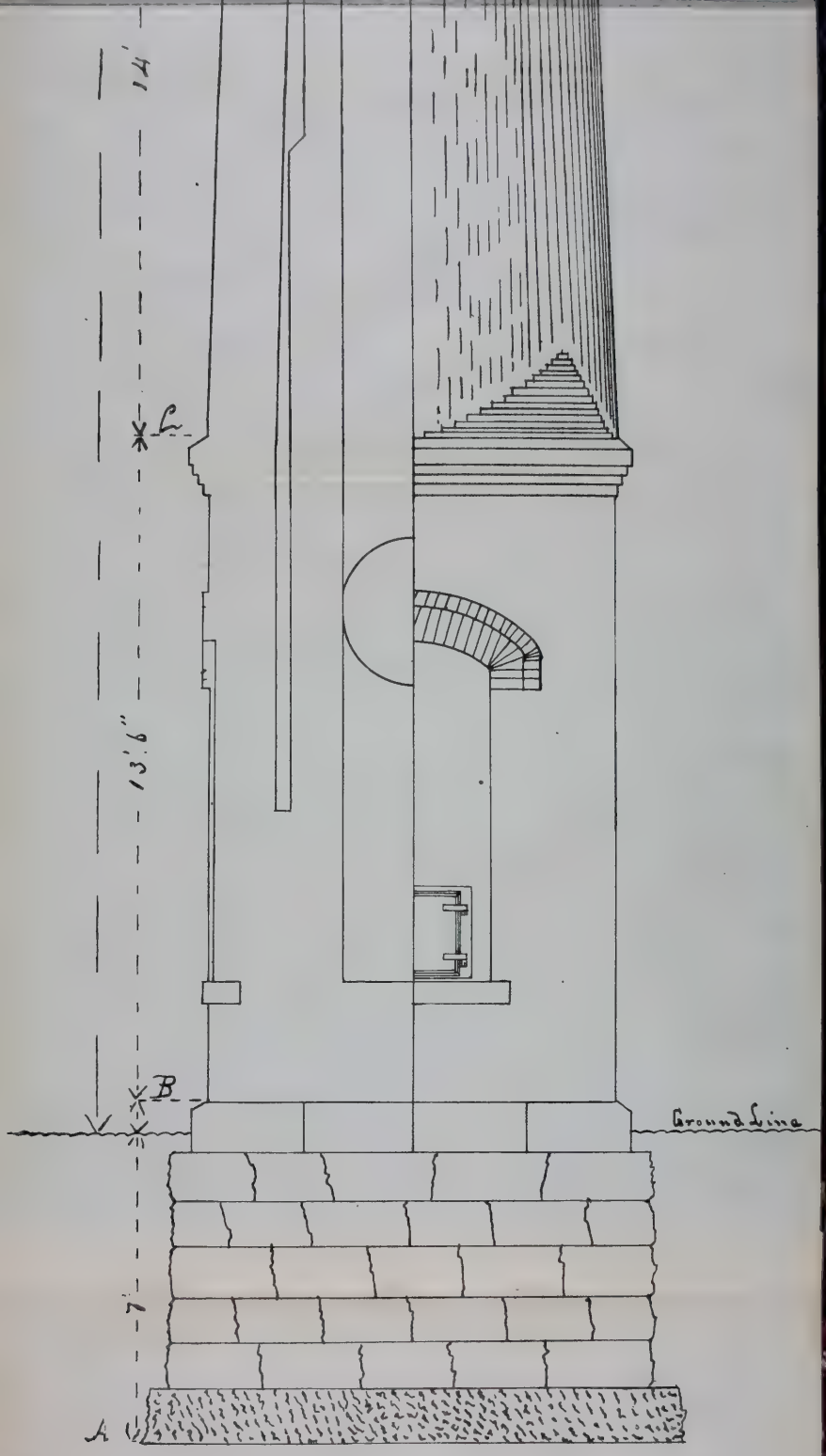
8"

Top.

Cross Section "E"

36"

8"



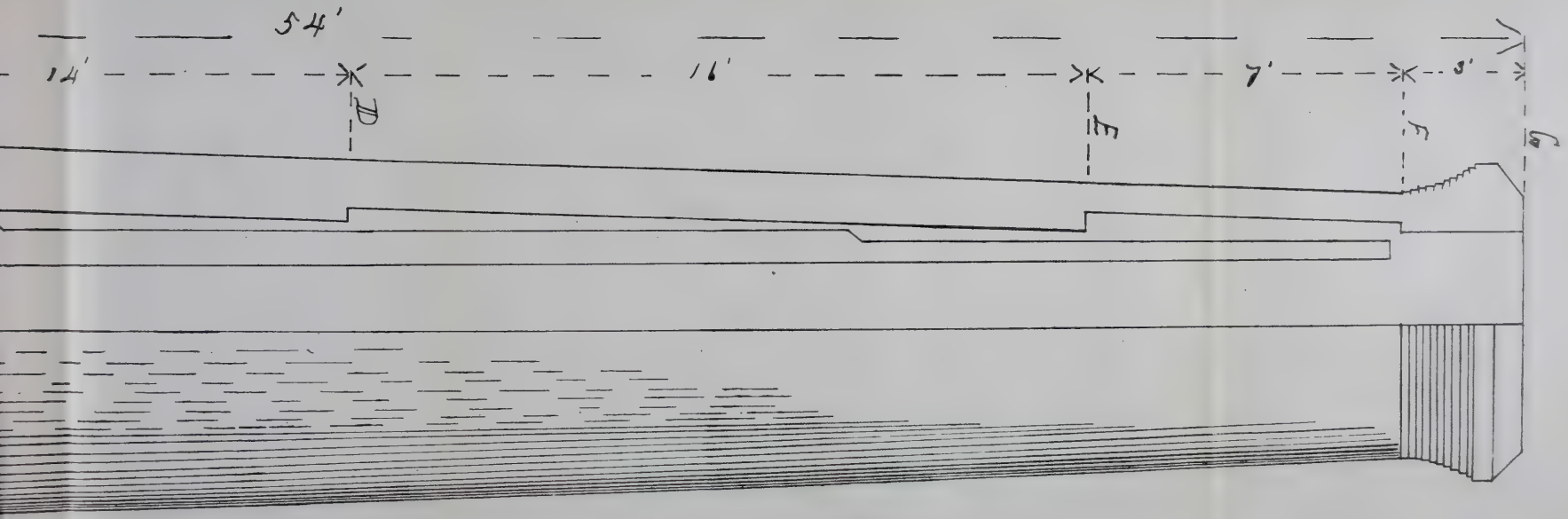
Chimney.

The Salina Water Works Co.

Scale 1/4" to 1 ft Batter 1" in 30".

Brick 43400

Weight on Base	66 Tons.
Weight on Foundation	114 Tons.
Weight per Sq ft of Stone Work	281½ Pounds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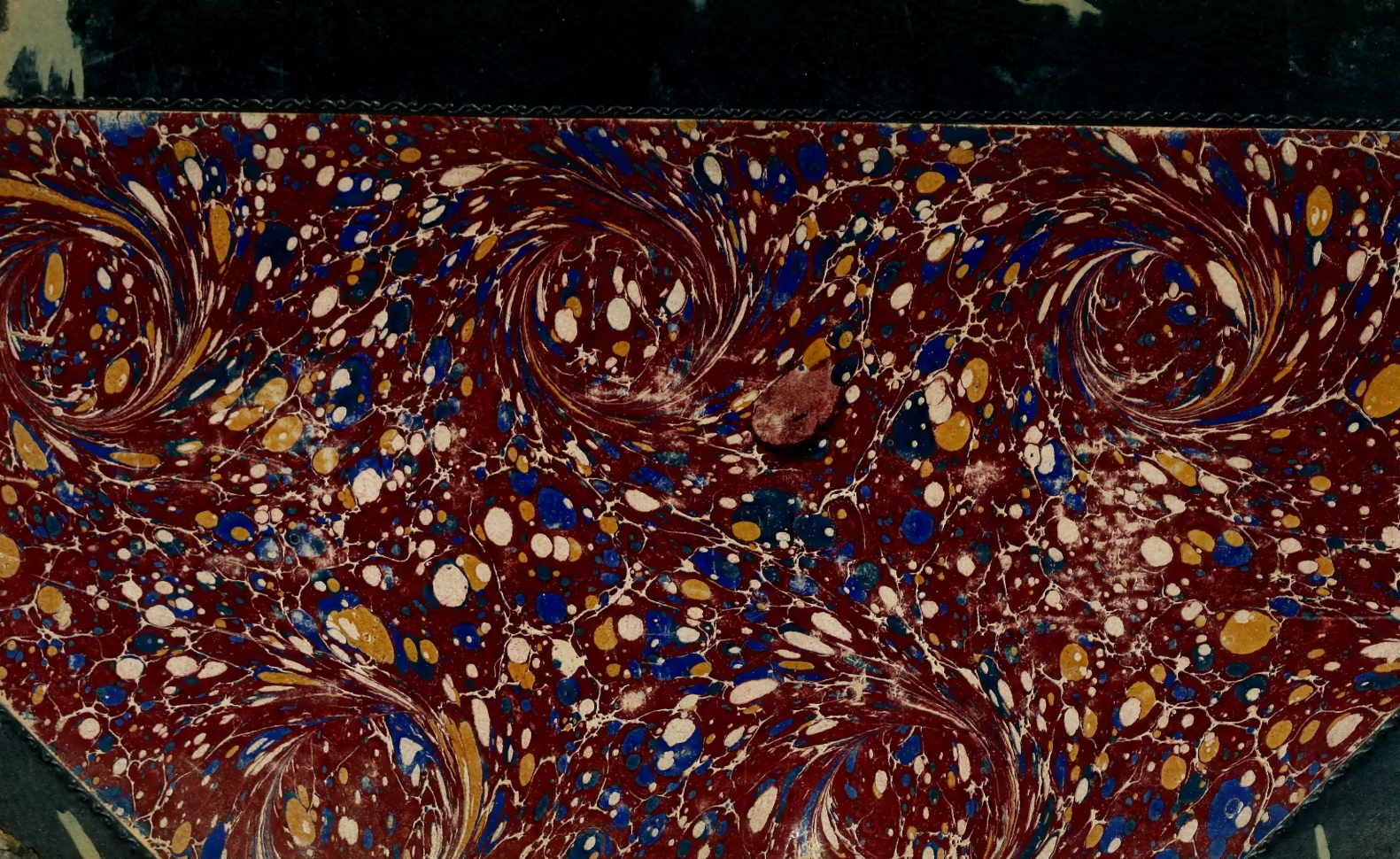
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